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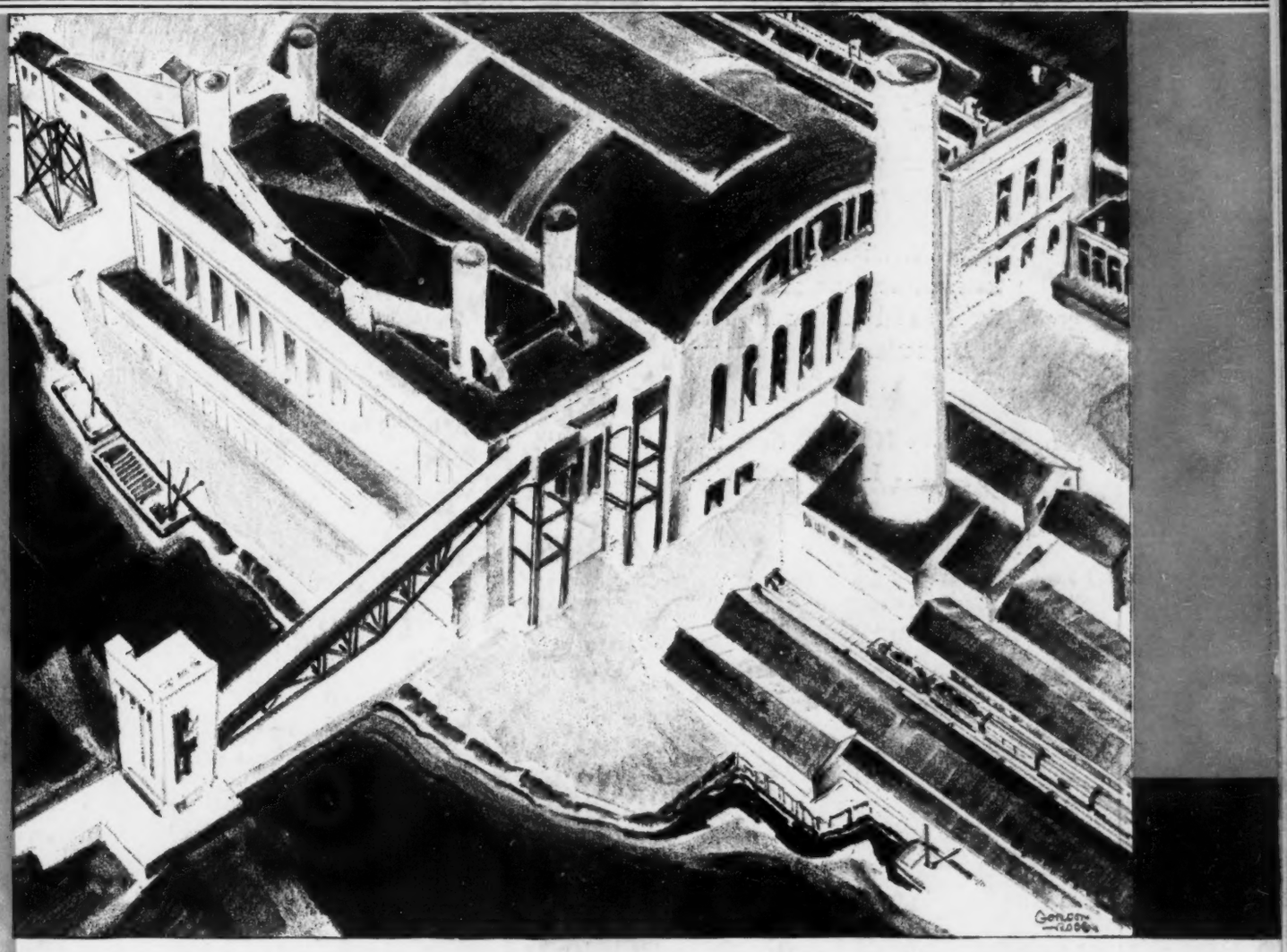

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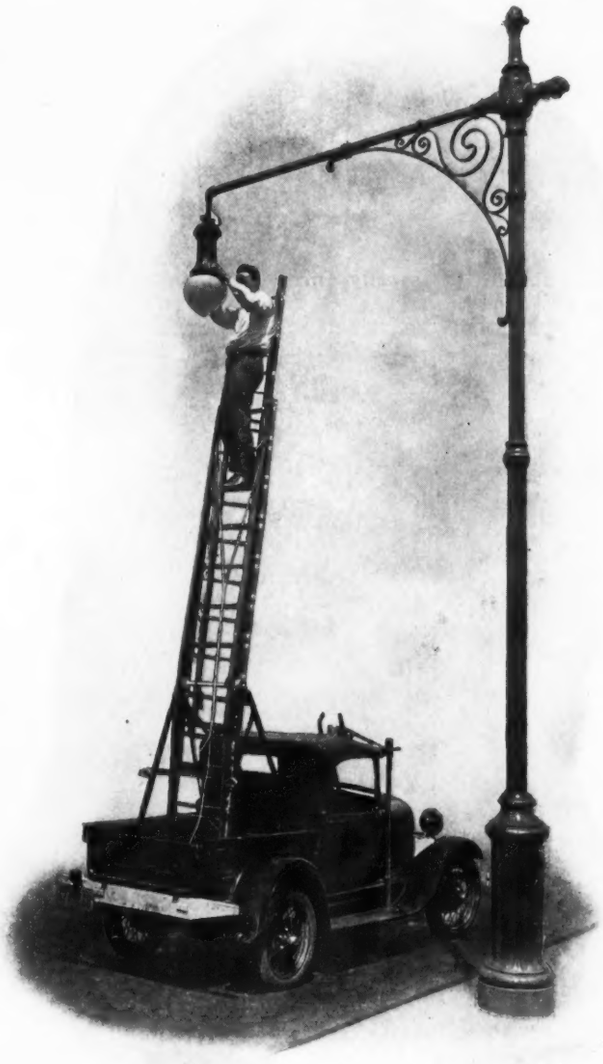

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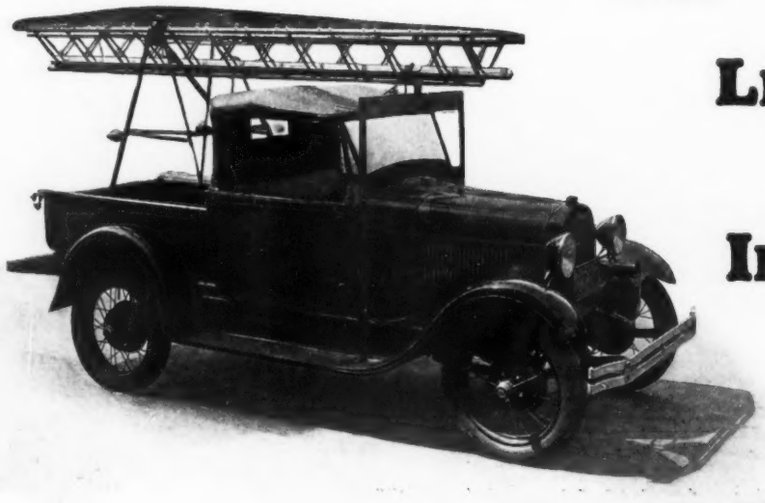

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Editor "Electrical World"

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The Over-all Economy of Quality

WITH increasing cost per unit of system capacity but decreasing revenue per unit of energy sold, much attention is being paid to reducing system investment and operating costs.

These matters raise the question whether savings can be made by changing either standards of materials used in power systems or in the present methods of operation, or both.

Every part of an electric power plant is important and each has its share in controlling continuity of service and cost of operation.

Long experience has shown that original construction costs cannot be wisely reduced by the use of materials not generous in quality.

It has also been definitely established that maintenance costs and failures are reduced to a minimum by equipment of high quality.

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Electrical World

A McGraw-Hill Publication—Established 1874

L. W. W. MORROW, *Editor*

Volume 94 *New York, Saturday, September 28, 1929* Number 13

Utility Costs Not the Answer

AFTER a careful survey of possibilities there appears to be little opportunity for a reduction in investment or in operating costs on utility properties. This conclusion is a very high compliment to utility engineers and managers and to the manufacturers of electrical equipment. It shows that despite an unprecedented rate of growth, a wide diversity in location and service conditions and a rapidly changing art, the present-day light and power company comprises a highly efficient assembly of equipment that is operated very economically. Nor is an increase in investment or in operating costs to be anticipated in the next few years, despite increased standards of service and an extension of facilities. Every indication points to the maintenance of the present level of values for investment and operation, and the future prosperity of the industry rests upon obtaining more and better business through sales efforts rather than upon making savings in investments or in operating charges.

Stagnation Not Imminent

But there is no possibility of stagnation in the situation even though the opportunities for economies of a major type are meager. In generation there appears to be an opportunity to reduce somewhat both the investment and the operating costs of steam stations. Higher pressures, higher temperatures, the operation of large units at high ratings, outdoor installations, the use of a binary cycle, new types of boilers and many other semi-experimental developments point in the direction of a reduced investment and a higher thermal efficiency. Perhaps the one outstanding opportunity is the development of materials and methods that will use high temperatures satisfactorily. In hydro-plant construction there is no indication of a reduction in unit investment or in unit operating cost and there is little opportunity for greater efficiency. Hydro developments in the future will justify themselves largely through a reduction of total generating costs brought about by the combined operation of steam and hydro plants.

In the transmission realm a major saving can be achieved once a way to control and ward off lightning is known. Lightning is the formidable enemy that necessitates duplicate lines, complicated relaying, expensive protective devices and enormous insulation factors of safety. About all the economies possible through interconnection are offset by the decrease in the quality of service that follows the greater exposure to lightning and the increased protective and reserve equipment necessitated by that hazard. The industry is penalized millions of dollars because of its ignorance of lightning.

Substation developments have been along the line of standardization and simplicity, and the practices in this field are splendid today. In outdoor, indoor and underground substation design and operation there appear to be only minor opportunities for making savings.

Distribution Warrants Attention

Most serious consideration should be given to the cost of distribution. Granted that service standards have increased, that transmission systems have been extended into lightly loaded areas and that civic demands have forced a greater underground area, little attention has been given to distribution savings. Losses of energy are entirely too large, transformers grow like mushrooms and their economic use is seldom checked, extensions are made piecemeal and on a basis of expediency, maintenance is mostly emergency repair, and in design and operation there is a general lack of improvement comparable to that found in the generating, transmitting and substation divisions of a property. With a contemplated industry program of intensified load building, it is imperative that the best possible skill in engineering and management be devoted to distribution. This division represents the greatest unit in system investment and in system operating costs. It shows possibilities for the greatest savings. It should no longer be neglected.

More Planning and Co-ordination

After all the divisions of a system are studied and after all advisable economies are introduced in each division, there is need for a study of the system as a whole. A modern utility is an enormous assembly of men and equipment that for obvious reasons has become departmentalized and specialized. The time is ripe for a planning or centralized

engineering department to study the system as a whole so that the development of each division or part of the system shall coincide with other developments to give a minimum total system cost. Herein lies a fertile field for making reductions in system investments.

In this issue will be found a large number of articles and items dealing with opportunities for cost reductions. They have been culled from all possible sources, and they give a tangible idea of what many have done to reduce costs. Beyond this, they show that utility engineers are now, as in the past, operating as highly efficient factors in the electrical industry. They and the industry are to be congratulated on the showing that has been made, for it proves that it is increased sales rather than reduced costs that will make a more prosperous industry.

❖

Mr. Lamont's Views Not Those of the Electrical Industry

THE international banking house of J. P. Morgan & Company has represented and dealt with many governments, including that of the United States. These relations to all appearance have been pleasant and profitable. Hence there is no reason why that banking house should have aught but good to say of governments and governmental enterprises. On matters of finance we doubt if there exists a more reputable or competent banking group anywhere. Other bankers admit the pre-eminence of the Morgan firm, and it enjoys to a remarkable degree the confidence and good will of both small and great. This reputation the firm well merits, and among no group is it more freely acclaimed and acknowledged than by the electrical industry.

When, however, a member of the firm of J. P. Morgan & Company speaks on any subject other than finance his utterances must be weighed and valued in the light of his experience and competency in the matter under discussion. Wide publicity was given last week to a statement made by Thomas W. Lamont of J. P. Morgan & Company regarding the harnessing of the waters of the St. Lawrence River. In it Mr. Lamont intimated that the manner of the development should be left entirely in the hands of the public authorities unhampered by the advice or action of public utility men. Of course, Mr. Lamont was speaking for himself and not for the electrical industry. Knowing little about navigation or irrigation, the electric light and power industry has not ventured any opinion on such matters; but, knowing more than any one else about the development and marketing of hydro-electric energy, the industry, responding to the highest call of citizenship and duty, has advised and undoubtedly always will advise and co-operate with the public authorities to the end that what is soundest and best from economic, engineering and commercial points of view shall, so far as the industry can help to insure such action, be built Any bond stamped by a responsible government suffices for a banker or investor, but the mere fact that a government chooses to engage in business in competition with its citizens is no guarantee that the project is sound or commercially feasible. History shows this to be so, and the electrical industry knows it to be so. Hence its objection to socialistic and paternalistic ventures of doubtful worth in a field in which the electrical industry is expert.

❖

More Misconceptions by a Big-State Governor

GOVERNOR ROOSEVELT'S attempt to cast aspersion on the Public Service Commission and to bring discredit on the public utility regulatory laws of the Empire State is neither ingenious nor statesmanlike. In order to make his point he intentionally or unintentionally ignores facts, thus resting his case entirely on fiction. For example, in a statement issued from Warm Springs, Ga., on September 22 the Governor of New York, speaking of the Public Service Commission and of state regulation of privately owned utilities, said: "Under the original theory a public service corporation desiring to operate in a given territory would go to the Public Service Commission and ask for approval of the project, the idea being that the commission would protect the company from 'wildcat' competition and guarantee a reasonable return on the invested capital by allowing such rates as would net such a return. What has happened, however, generally speaking, is that the capitalization of the big public utility enterprises does not by any means represent the actual money invested in the properties. As a matter of fact, the actual money investment is a comparatively small part of the capitalization. Nevertheless, the corporations still claim the right to receive a reasonable return on their total capitalizations, which include in almost every instance great quantities of watered stock representing no actual cash investment."

Now, the Governor knows, or ought to know, that the Public Service Commission does not guarantee earnings to a public utility, much less a reasonable return on investment. If a utility by dint of initiative, operating skill and the exercise of sound business judgment manages to earn a reasonable return on its investment, it is entitled to it. Anything beyond that is pre-empted by reduction in rates. But when the Governor asserts that the Public Service Commission permits the utilities to earn a return on watered stock he exhibits a lamentable lack of information on the workings of the New York Public Service Commission. That commission expressly prohibits any return on capital not actually invested in property set aside for public use. It bases its rates on actual valuation and not on financial structures or engraved paper, and in stating otherwise the Governor does the commission a gross injustice.

The regulatory laws of the State of New York are among the best and safest in the country, and the

personnel of the commission does not suffer by comparison with that of other state commissions. If the commissions are not the best obtainable—and we are not maintaining that they are not—the fault in states like New York lies primarily with the executives who appoint them. The Governor ought, in justice to himself and to the commission, first to acquaint himself with the commission law and the decisions made by various commissioners under that law before issuing any more statements regarding the inadequacy of the law or the incompetence of the commission.

❖

Men and Experiences for Export

GREAT BRITAIN, Italy, Russia, Germany, France and many other countries are now active in the development of an electric power supply of a type comparable to that found in this country. These nations attribute a large part of our national prosperity to the free use of power and consider a power supply necessary to their own economic growth. They seek ideas, equipment and men from this country, and electrical interests here contribute gladly to this new means for obtaining international co-operation and understanding.

Whether foreign developments are made by private interests or by the governments, there are common problems of management and engineering that our utilities have solved satisfactorily for our conditions, and there is little doubt that other nations can use our ideas and experiences. Just now most of the foreign developments are concerned with the building of stations, lines and substations to get large interconnected assemblies of electric power apparatus. The need is for the engineering and operating experiences available from our large properties, and many American engineers are called upon as consultants. Later there will be need for experienced managers and operators and the other elements essential to a large-scale utility enterprise.

It is to be hoped that the present popularity of electric power supply in foreign countries will be associated with a balanced program. There is little doubt of the ability to build a physical structure that can supply power, but it must not be forgotten that the power must be used if the enterprises are to be prosperous. There must be education in the use of power and there must be sales effort. The experiences of large utilities here afford ample evidence that power stations, transmission lines and rate schedules do not of themselves convert a nation to the use of electric power. Tradition, competition and habits must be overcome, and the most difficult part of the management problem is sales—not construction, engineering and operation.

In the initial stages of national power supply attention should be given to all elements of the utility business, and our experience should help other countries to develop their electric power supplies without making errors and in a minimum time. It has taken this country many years to reach the present power status, and mistakes that were made can be avoided and the work expedited if the lessons in the American textbooks are well learned.

❖

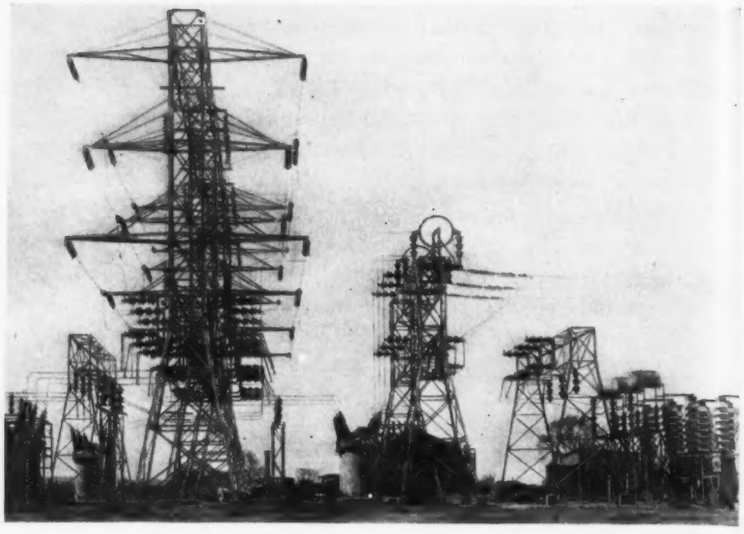
Too Much Guesswork Impairs Cost Data

ECONOMIES in electrical design and construction are always being sought by alert engineers. The full realization of savings possible through the more efficient use of labor and material depends on complete understanding of field conditions and also upon adequate records. Too often the economies achieved by skillful designing or able construction methods are not evaluated properly during the progress of the work. The engineer knows that a particular course, method or choice of equipment will pay its way and more, and lets it go at that as long as his decision is clearly sound. He may think he is too busy to assemble cost analyses on specific jobs while the payroll and material sheets are accessible and fix a rough over-all dollar figure or percentage figure in his memory as applicable to this or that case. As soon as the job is over he may be rushed into another one a hundred miles or more away. The field sheets go into the archives of the accounting department, there to repose.

If ever the old adage of striking while the iron is hot applies to engineering economics, it is while engineers competent to analyze costs and reach more than roughly approximate conclusions are in daily contact with design and construction problems on specific jobs.

***Taking the industry as a whole, investment costs per kilowatt of installed capacity are increasing. The revenue per dollar of investment is decreasing. I believe we can properly rely on our engineers to work out ways and means of reducing investment costs, or at least of holding them down to minimum figures. I know they are working on that problem, and they have never yet undertaken a problem without achieving a solution which was an advantage to the industry and an advance in its technique.*—M. S. Sloan.**

Construction Work Shows Cumulative Economies



Oneida Substation of New York Power & Light Corporation

AS IN previous years, every essential element of the utility plant has been built and assembled with continued striving for low first cost and minimum operating charges in mind. Generating stations, transmission lines, substations, distribution facilities and incidental engineering all reflect the sustained pressure to reduce the cost of supplying service. *Electrical World* again presents its review of money-saving practices.

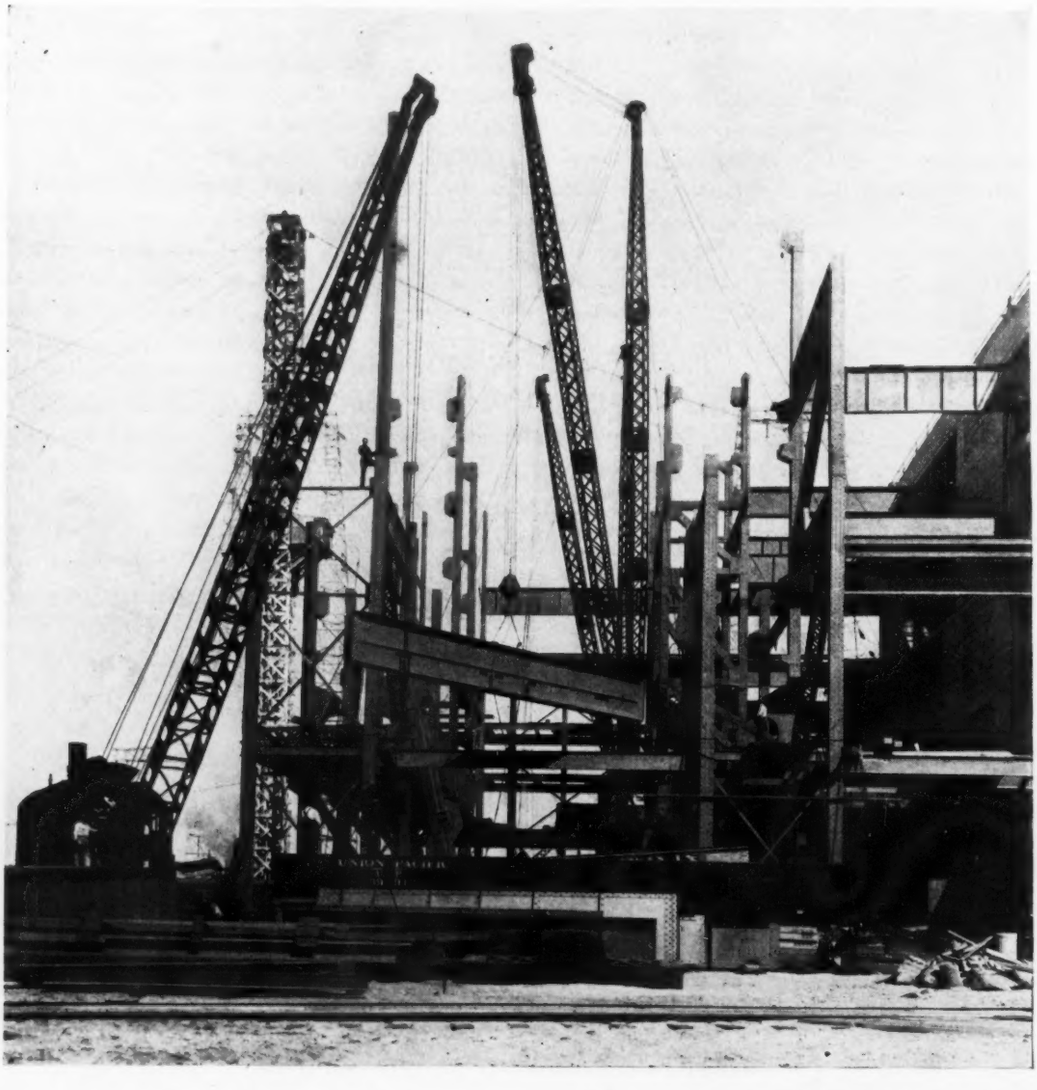
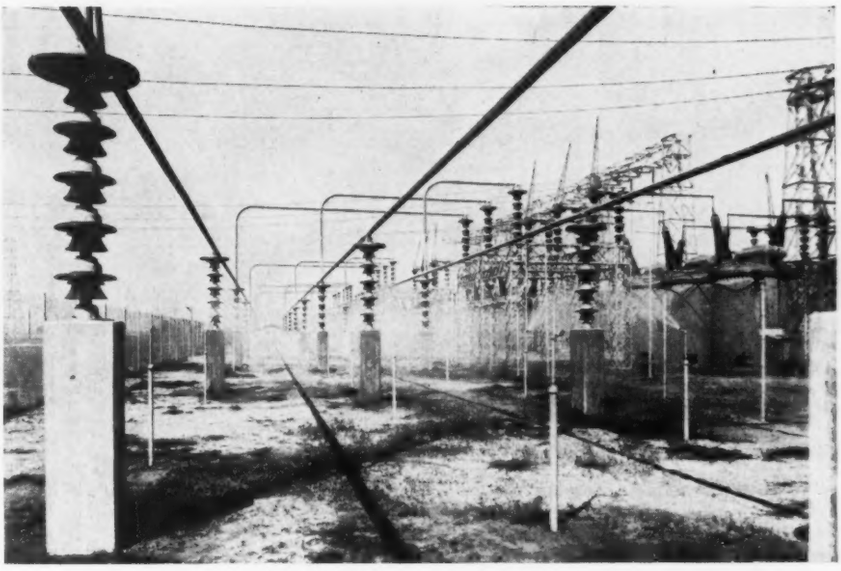


Photo Courtesy G. Haven Bishop

Steelwork for Long Beach Steam Plant No. 3 of Southern California Edison Company

Pedestal Bus Supports

Reduce Substation Cost



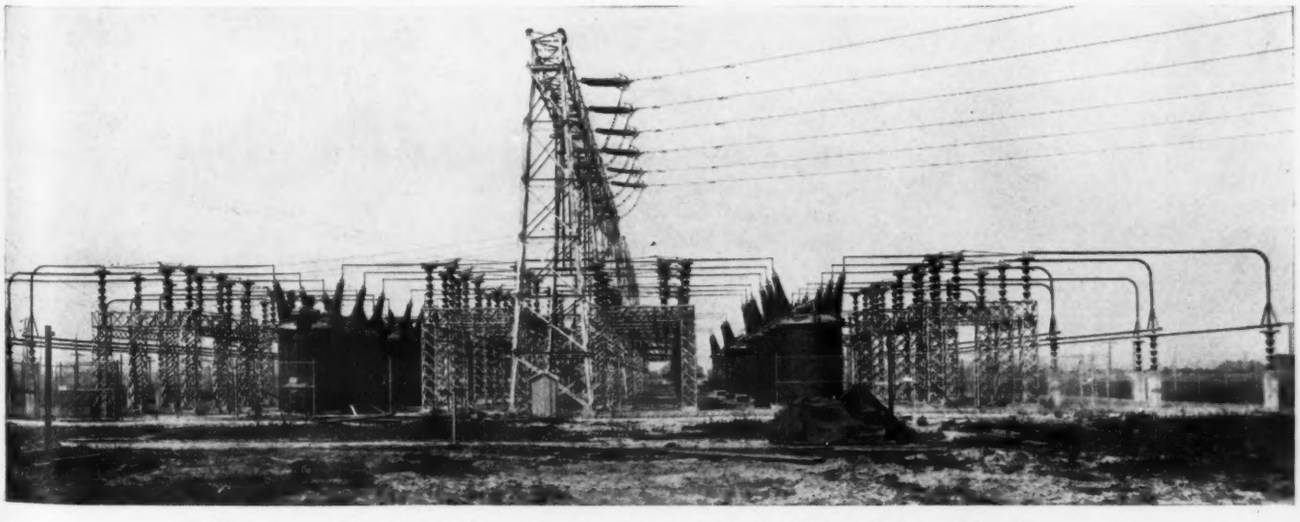
Single-Unit Insulators Will Support New 66-Kv. Substation Buses

DECISION to omit lightning arresters on individual circuits and install them instead on each main transformer bank and use of air-insulated current transformers has made it possible for the Southern California Edison Company, according to R. B. Pollock of the department of engineering and design, to adopt a new type of 66-kv. switch-rack, resulting in a very material reduction in substation construction costs. The new type of 66-kv. switch-rack is for double bus and is similar to the type of 220-kv. bus and rack originated by the Edison company as shown in the accompanying illustrations.

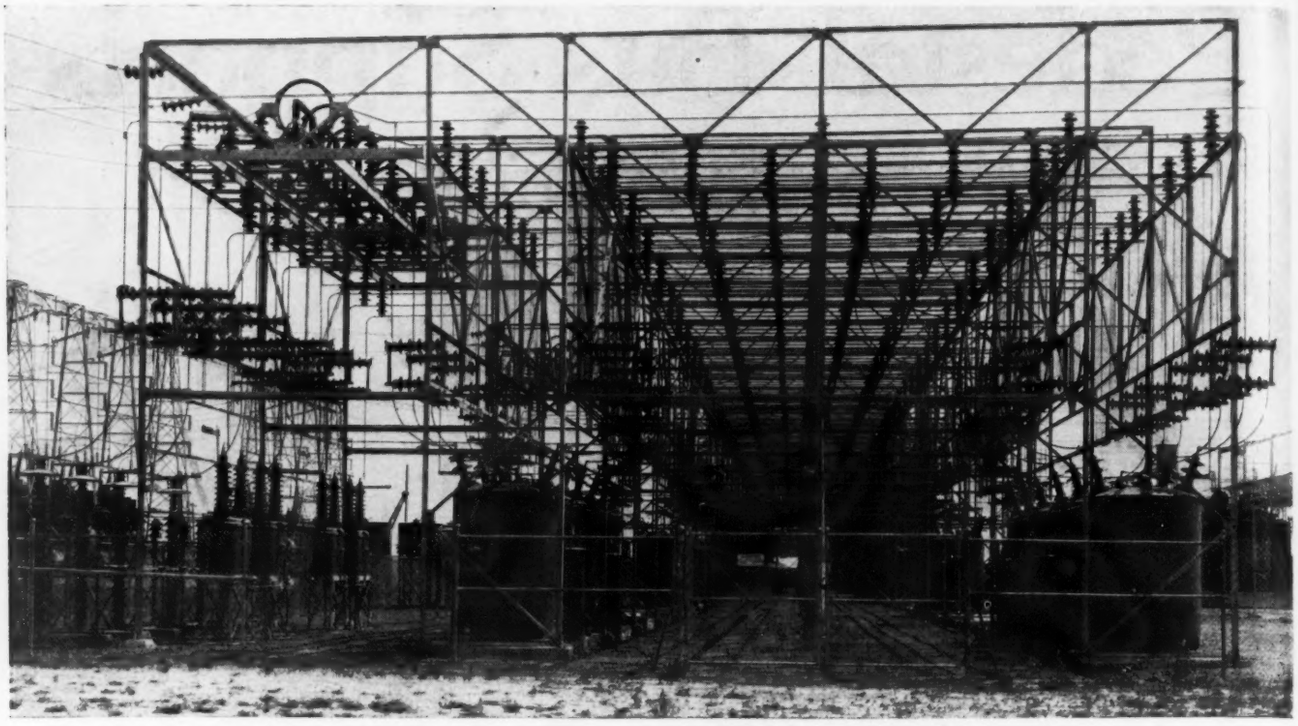
Circuits are dead-ended to a steel "A" frame structure. Each bus with its oil circuit breaker and disconnecting switches is located on either side of the dead-end structure. The line jumper loop is tied directly to the current transformer, which is mounted near the top of the "A" frame.

Copper tubing is used to connect the current transformers to the clip end of the two line disconnecting switches on either side of the tower without necessitating any other insulating support. The hinged ends of the line disconnecting switches are connected to the oil circuit breaker bushings with one span of tubing. A low frame structure supports the bus disconnecting switches in a horizontal position and single spans of tubing are used to connect them to the oil circuit breakers and the buses.

The buses are supported from the ground on vertical 3-in. iron pipes and single-unit insulators, the supports



220-Kv. Bus and Switch-rack After Which 66-Kv. Substations Will Be Patterned for Economy



66-Kv. Switch-rack Showing the Great Mass of Steel Work Eliminated by Newer Design

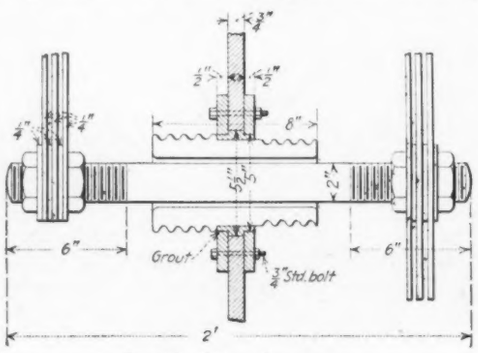
occurring at the taps only. Single-unit 73-kv. insulators also are used on the current transformers and disconnecting switches. The disconnecting switches are three-pole gang operated with remote hand control. The remote control is necessary for the bus disconnecting switches due to the fact that they are mounted in a horizontal position for ease of connection.

The economies of this new type of construction as compared with the former type of steel rack illustrated are evident. The estimated cost of the new type rack is $1,600 per bay, as against $2,500 per bay for the older type rack. This means a saving of $900 per bay, or $27,000 for the thirty-position rack at the new La Freza substation, where this type of construction is first being used. These costs include only steel, concrete, insulators and safety screens and are independent of apparatus. The ground area required is approximately the same for either type of construction. Both racks can be adapted to use the same apparatus with the exception that the new type will not accommodate lightning arresters on the individual lines. Aside from the economies, it is felt that the new design is superior to the old type in that it is much more simple and less hazardous to maintain and operate.

Solid Rod Bus Connector Simplifies Installation

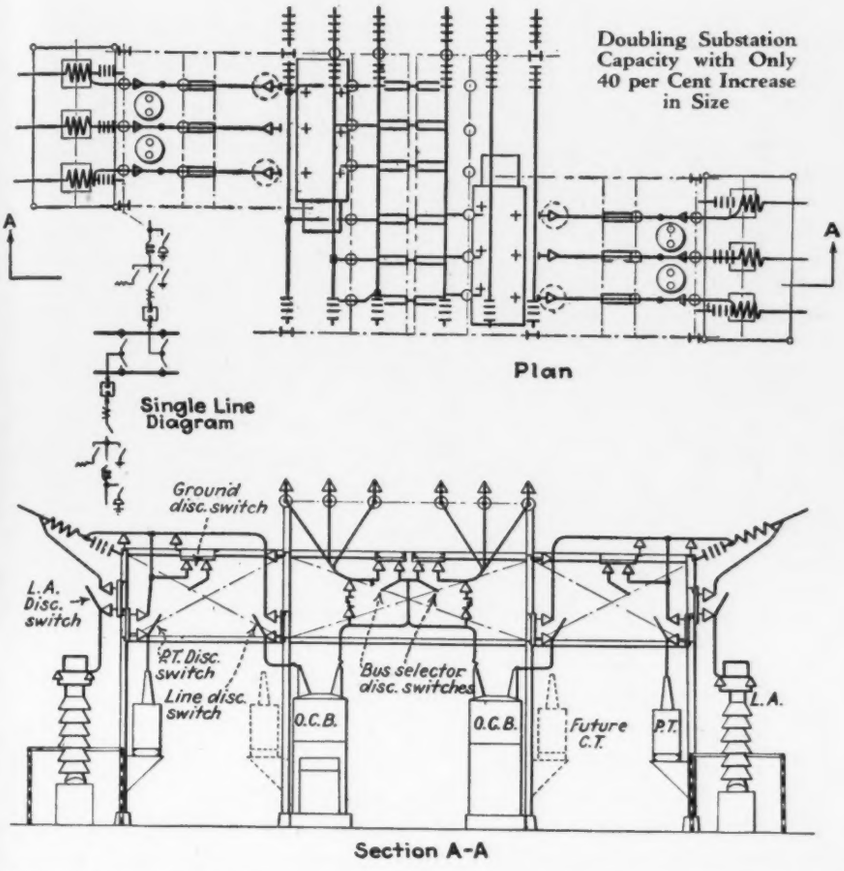
AS A rule the connection of two heavy capacity buses in a limited space is a difficult problem, calling for a relatively short but heavy copper section that will easily fit into the space between the bus taps across an insulating barrier. This connection must be shaped to fit the bushing passing through the barrier, whether of transite or other material. The usual design for such a connection involves in a typical case the use of 2-in. x 4-in. copper stock, cut and bent to fit the bars at each bus tap and made up in two pieces per phase to facilitate assembling and requiring at least three sets of bolted connections per phase. At best this is not very satisfactory, as there are likely to be a number of points of poor conductivity due to so many bolted connections.

In a representative instance this problem was solved by the use of a solid rod connector 2 in. in diameter, giving an effective cross-section area of 4,000,000 circ.mil and comparing favorably with the area of the bus taps, which were assembled of three 4-in. x ¼-in. copper bars. The rod was threaded at each end and secured to the bars by hexagon nuts, using jam nuts ¼ in. wide for inter-bar spacers. This construction allowed the use of a standard round wall bushing which is attached to the barrier by transite strips. The space between the transite and the outer surface of the bushing is cement grouted to make the connection gas-tight. This method resulted in saving copper, in a price economy through the use of a round bushing instead of a square bushing and also saved labor in assembly.



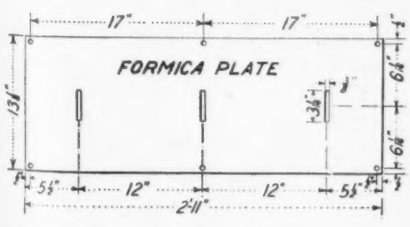
Detail of Bus Connector

Staggered Layout Keeps Substation Small



THE New York Power & Light Company, according to C. A. Bacon, electrical engineer, has effectively kept the size and cost of substations down by resorting to a staggered layout of the apparatus. In the case of a 33-kv. station, similar to that represented by the diagram, an increase in length from 15 ft. to 21 ft., a 40 per cent increase, provided for doubling the substation capacity. The interconnection with this arrangement helps to minimize the insulators and accessories required in connection with the disconnect switches and leads from one piece of equipment to another. The same idea is used for 13.2 kv.

Slotted Formica Sheets Support Buses



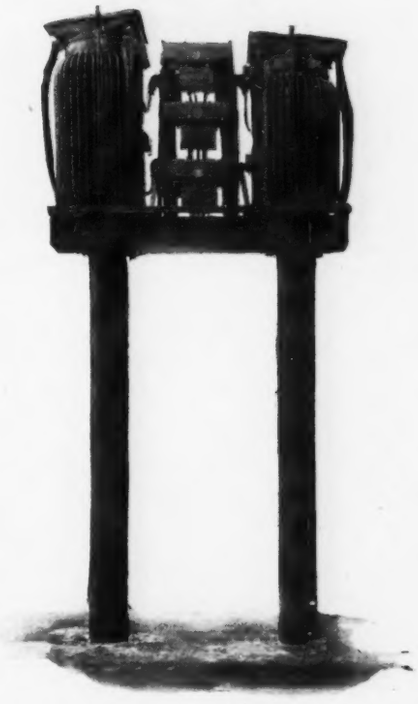
DURING the past five years the West Penn Power Company has employed a type of bus support on its 4,000- and 2,300-volt indoor buses which is a departure from conventional practice, according to E. W. Rand, assistant substation design engineer. In place of the usual porcelain insulators, this company has used rectangular sheets of formica through which slots have been cut as shown in the sketch.

The 4,000- and 2,300-volt structures consist of a number of cells arranged in a line along one wall of the building and are built from steel sections and plates. Above the oil circuit breaker and in the same cell are placed disconnecting switches that disconnect the breaker from the main bus. Each steel barrier between adjacent cells has a rectangular hole in it slightly smaller than the formica sheets and located at an elevation above the disconnecting switches. Two formica sheets are secured with bolts over the hole in each barrier, one sheet on each side. The main bus passes through the slots in the formica sheets and extends the entire length of the structure. By making the slots through which the bus passes but very little larger than the bus itself, it is held extremely rigid.

During the period that the West Penn Power Company has been using this type of bus support there have been no bus failures experienced by the company due to the support failing either electrically or mechanically. In light of past performance, it is felt by the company engineers that this fine record is sufficient recommendation for its use in future designs whenever possible.

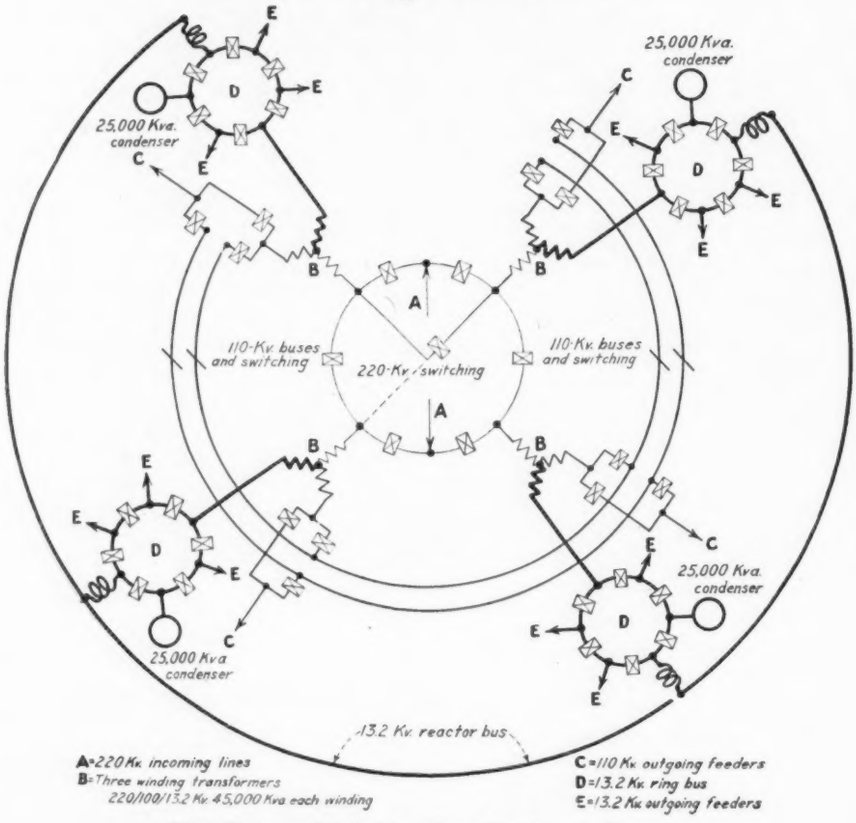
Not only has this type of bus support effected a saving by reducing the number of interruptions to customers' service, but it is approximately 10 per cent lower in cost than porcelain insulators applicable to the same type bus structure.

Neat and Simple Platform



PREVIOUS to the development of a water-proof manhole to combat tidal flooding at Coney Island, the Brooklyn Edison Company installed transformers on platforms supported on two legs of 10-in. pipe. The secondary and primary leads to the ducts were carried inside the pipe supports.

Duplicate Feeds Without Duplicate Switches



Ring System of Switching Saves Breakers in Toronto

THE switching arrangement used in the Toronto-Leaside substation of the Hydro-Electric Power Commission of Ontario provides the choice of two feeds to each piece of equipment or feeder, so that any switch may be taken out for maintenance without interrupting service, nad still accomplishes this result with only one more switch than there are pieces of equipment or feeders served. In this way 40 per cent of the switching equipment required in the ordinary bus arrangement is saved, according to E. T. J. Brandon, electrical engineer.

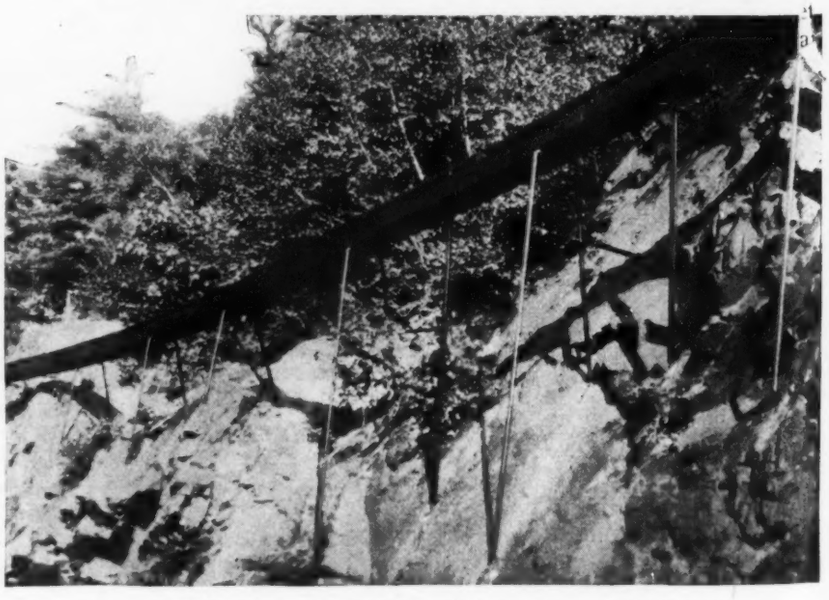
For example, referring to the diagram, 220-kv. lines from the Gatineau Power Company enter at *A*, and can supply power over either of two paths to three-winding, 220, 110, 13.2-kv. transformers connected with the 110-kv. and 13.2-kv. ring buses.

The 110-kv. bus is not a completed circle, but is laid out with a view to providing a feed to two or more separate 110-kv. lines. However, the circular principle is carried out in the 13.2-kv. bus. Three 15,000-kva., single-conductor, lead-covered cables distribute the output of 45,000-kva. transformers to a local distributing substation. Station reactors are placed between a reactor bus and each of the 13.2-kv. circles. There are also reactors on the 13.2-kv. feeders. Each 13.2-kv. circular bus is connected with a 25,000-kva. condenser.

Assuming the capacity is ultimately doubled, the calculated values of short-circuit kilovolt-amperes are approximately as follows: 13.2-kv. bus, 1,000,000 kva.; 110-kv. bus, 1,600,000 kva.; 220-kv. bus, 2,000,000 kva.

Cable Flume Traverses Rock Cut

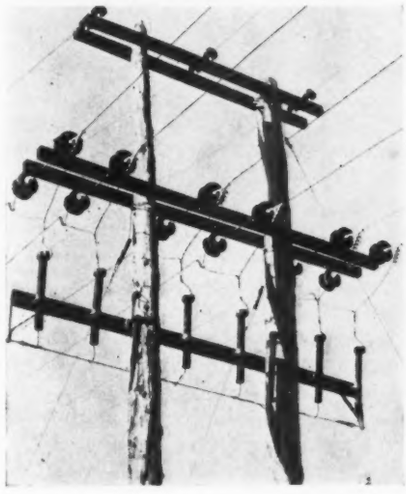
IN LAYING a 22-kv., three-phase, underground cable between Beverly and Gloucester, Mass., along the right-of-way of the Boston & Maine Railroad, the engineering department of Charles H. Tenney & Company, Boston, encountered a rock cut several hundred feet long near Manchester where excavation and blasting were too costly and objectionable to be attempted. J. C. During, resident engineer, met the problem by designing a wooden flume of kyanized spruce plank to carry the cable through this section, with provision for a 2-in. side ventilation near the top and 4 in. open space in the bottom of the structure. The flume is anchored into the ledge by $1\frac{1}{4}$-in. pipe and $\frac{5}{8}$-in. bolts expanded into the rock, 2-in. x 4-in. channel irons being provided beneath the box at every bent. The conduit is composed chiefly of 2-in. x 6-in. and 2-in. x 8-in. plank and is 10 in. high x 12 in. wide inside. Slats of 2-in. x 3-in. stock are provided at 2-ft. intervals inside the conduit to support the cable, which is a 250,000-circ.mil, paper-insulated, lead-covered conductor. The top of the flume is bolted to the sides, rendering the



Pipe Supports Attached to Rocks by Expansion Bolts

cable accessible, and the flume is large enough for a second cable to be placed in the future.

Economical Arrester Installation



IN A New England country town three 13-kv. overhead lines serve the community through an outdoor substation which is provided with an unusually simple and inexpensive installation of standard lightning arrester. The two lower lines shown in the halftone are dead-ended at strain insulators attached to either crossarm of a pair mounted directly above an arm carrying a pellet type arrester for each phase wire. Jumpers are looped below the double arm between line clamps and at the bottom of each loop a tap a few inches long suffices for the arrester connection. Below the battery of six arresters a horizontal run of line wire constitutes a common ground bus, with appropriate earth connection. On account of local conditions the arresters for the top circuit are mounted elsewhere. The arrangement employs a minimum amount of material and retains the advantage of accessibility and clarity of connections.

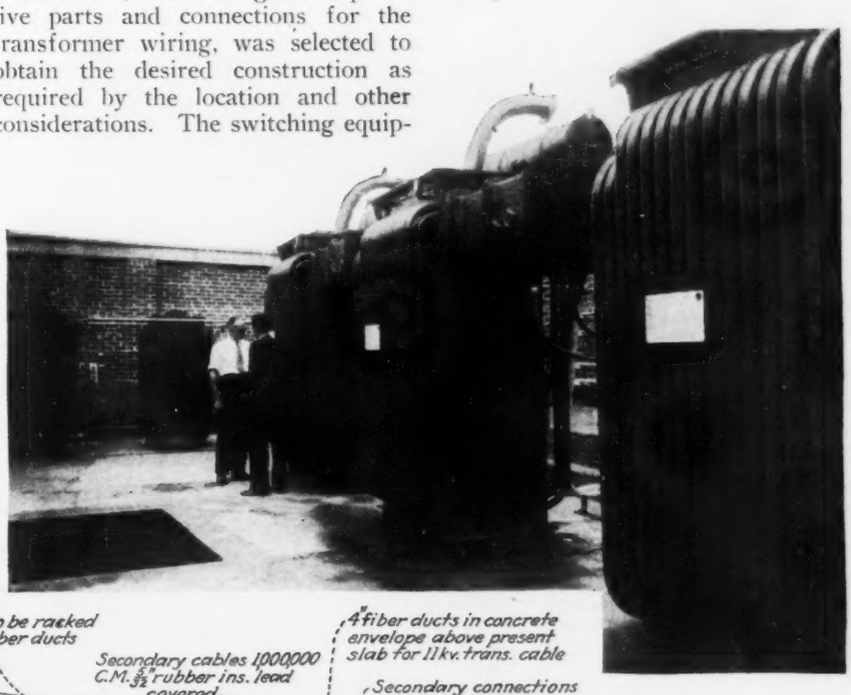
Simplified Design for Industrial Substation

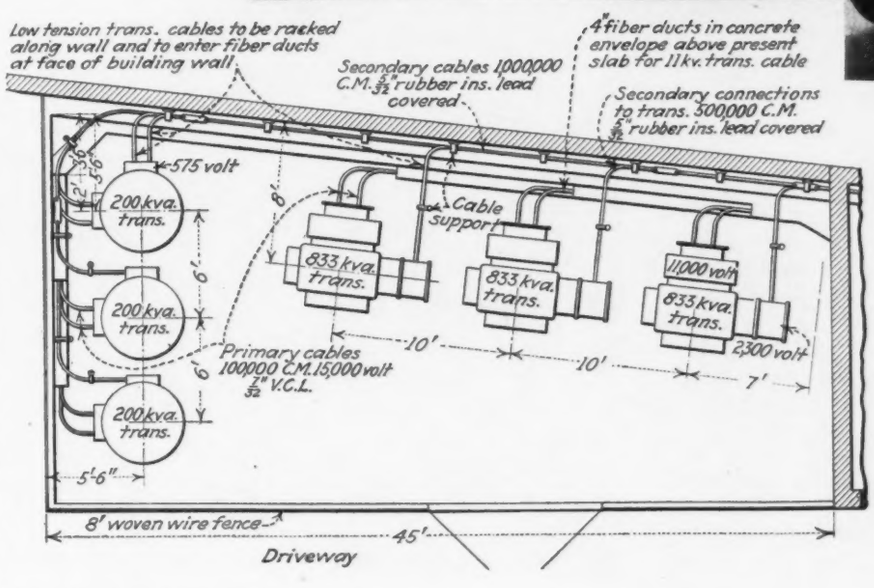
SIMPLICITY of design and safety of operation are incorporated in an industrial type substation recently installed by the Narragansett Electric Company, Providence, R. I.

Due to the fact that the only available location for the station was adjacent to a wall on the property line separating the customer's property from a much-traveled street and sidewalk, special consideration was necessary with regard to the type of transformer structure. The usual overhead steel structure for bus work and other electrical equipment could not be used on account of inadequate clearances. A building to house the transformer was also undesirable from an over-all cost standpoint. Consequently, the pothead type of transformer, eliminating all exposed live parts and connections for the transformer wiring, was selected to obtain the desired construction as required by the location and other considerations. The switching equipment was placed indoors, thus utilizing standard indoor equipment, conserving space and also realizing greater safety in operation.

The element of economy is also apparent. Besides avoiding the cost of a building to house the transformers, the moderate increased cost of the pothead type of transformer is neutralized by the elimination of overhead steelwork and foundations.

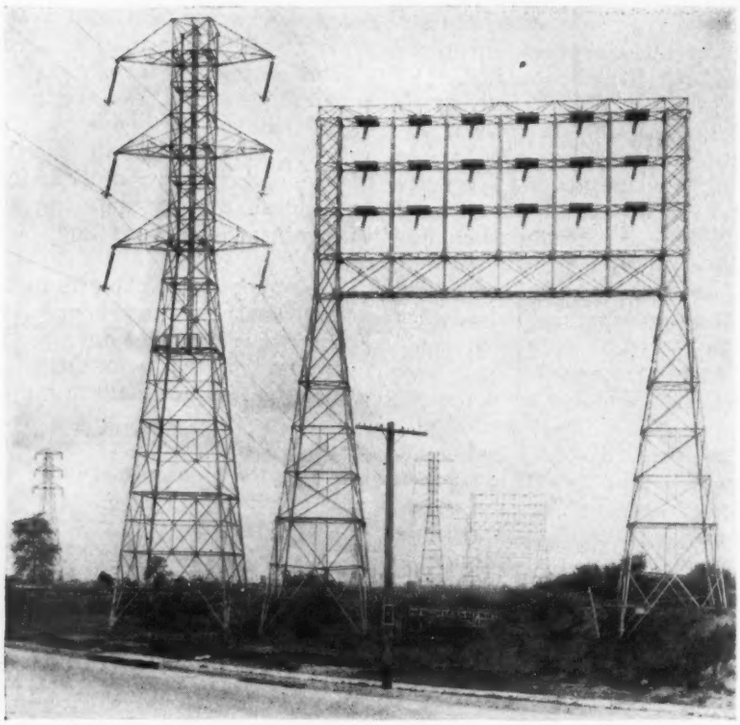
Single-conductor cable is used for both primary and secondary wiring, and provision is made for open delta operation of the bank in case of trouble on one unit, with a minimum amount of work for cable rearrangement. The cables are inclosed in ducts in the transformer yard wherever possible.




Low tension trans. cables to be racked along wall and to enter fiber ducts at face of building wall
Secondary cables 1000000 C.M. 5/32" rubber ins. lead covered
4" fiber ducts in concrete envelope above present slab for 11kv. trans. cable
Secondary connections to trans. 300000 C.M. 5/32" rubber ins. lead covered
575 volt
200 kva. trans.
200 kva. trans.
200 kva. trans.
Cable support
833 kva. trans.
833 kva. trans.
11000 volt
833 kva. trans.
2300 volt
Primary cables 100000 C.M. 15000 volt 5/32" V.C.L.
10'
10'
7'
6'
6'
6'
5'-6"
8' woven wire fence
45'
Driveway

Pot-head Transformers Avoid Overhead Bus and Supports

MULTI-CIRCUIT TOWERS



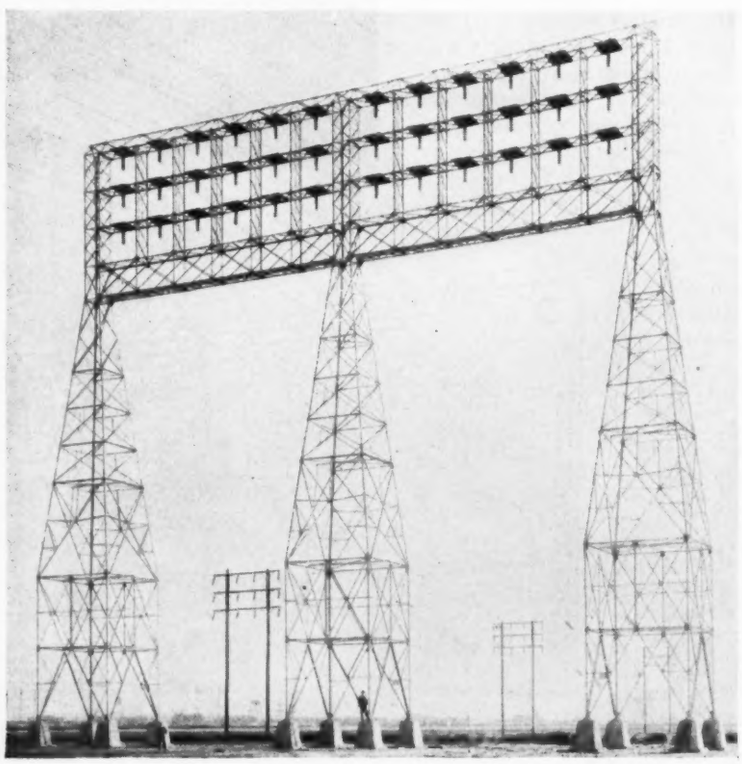
By C. B. Carlson
Structural Designing Engineer
Southern California Edison Company
Los Angeles, Calif.

NECESSITY of providing for a number of additional 66-kv. transmission lines from its Long Beach steam plant, coupled with the high cost of rights-of-way through developed industrial and residential areas, first led the Southern California Edison Company to consider the use of multi-circuit towers carrying as many as fourteen circuits. The first of such towers erected were those in the line from Long Beach steam plant to Lighthipe substation, but with the success and very obvious economies in structure and right-of-way costs on this job, the use of multi-circuit towers has increased quite rapidly until now they are being used almost exclusively in the territory which surrounds Los Angeles.

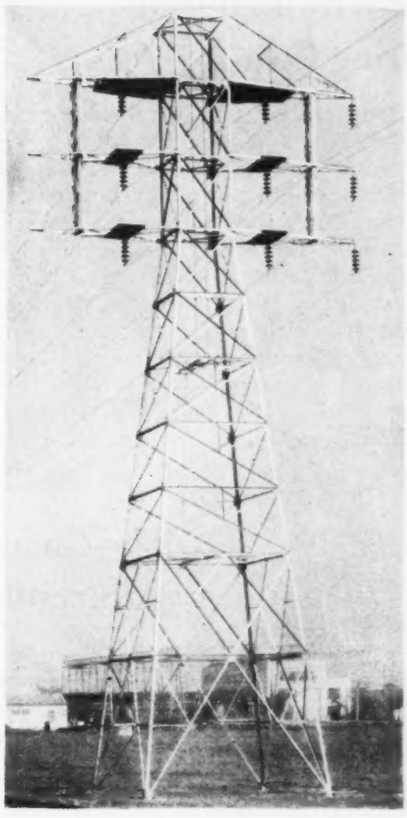
The accompanying illustrations show the several types of towers designed and used to combine 66-kv. circuits of from four to fourteen in number. Briefly the structures consist of towers with a latticed box girder between, supporting the cross-arms which span between the upper baskets of the towers. This box girder, besides supporting the cross-arms, furnishes a runway below the circuits from which access may be had through gates to the circuits for maintenance or inspection. A separate lock and key is provided for corresponding gates on each tower and when men are sent out to work on a line the dispatcher issues only that key to the circuit which has been cleared. This prevents any possibility of men getting onto energized circuits.

The advantages in the multi-circuit type of construction over the use of a number of double-circuit structures may be summed up as follows:

1. Saving of at least 25 per cent in rights-of-way. More will be saved where ground conditions govern. In the case of the double-circuit towers for fourteen circuits there will be seven footing locations required, as against three in the multi-circuit towers.
2. Saving of about 10 per cent in the cost of the steel based on the same mechanical loading in each case.
3. Saving of about 50 per cent in the footing cost, as only three towers are required in the multi-circuit against seven in the double-circuit towers.
4. Saving of time and money in



Solve Right-of-way Problem



the maintenance of the line during operation. A patrolman need climb only one tower to work on any or all of fourteen circuits, while he might have to return to the ground seven times in the case of the double-circuit towers.

5. Reduces the hazard of contact with legs of towers and permits the use of the right-of-way to better advantage.

6. The circuits and structures on the right-of-way offer a neater and more regular appearance, making their presence less objectionable.

7. The multi-circuit structure is a solution for restricted conditions of rights-of-way widths where get-away must be obtained with a large number of circuits.

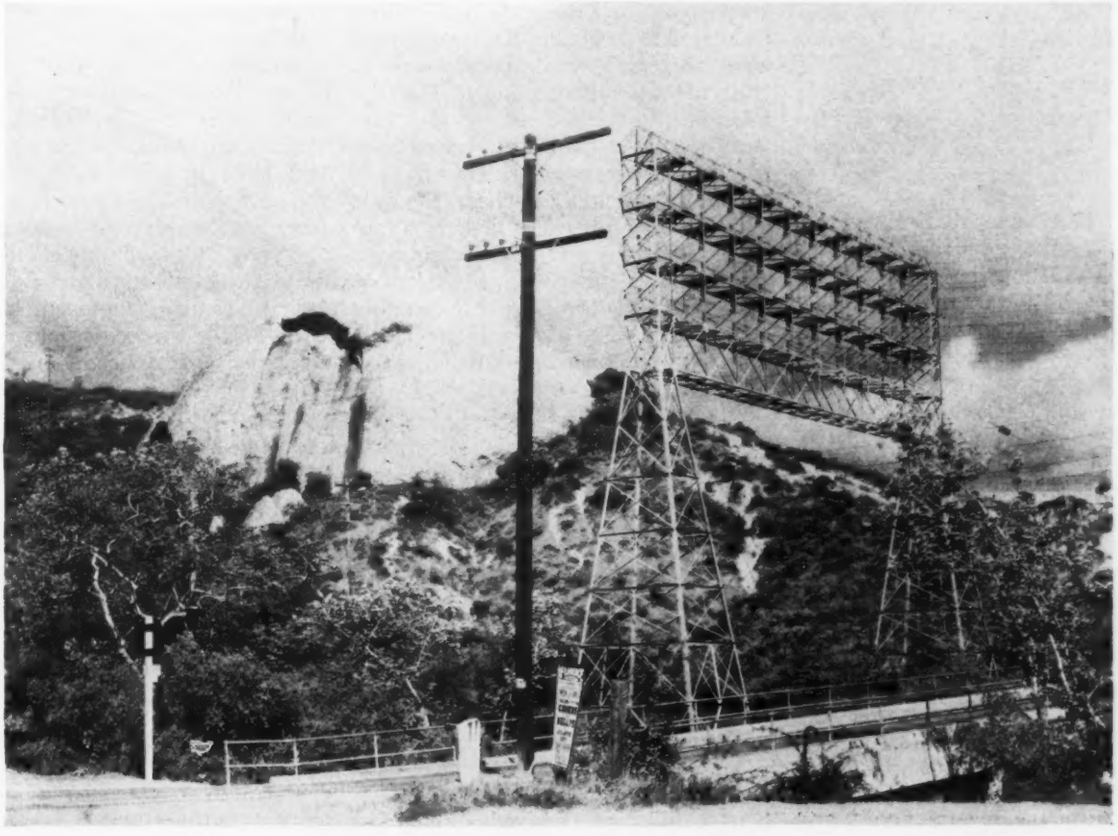
These towers measure 71 ft. to the lowest wire and are used for spans up to 1,000 ft. and that the factor of safety in strength was increased because of the highly developed country where such towers are used. These points are mentioned in order that like quantities will be compared.

References have been made to structures carrying fourteen circuits, but the following towers have been designed and erected: Four circuits on one tower, six and eight circuits on two towers with connecting bridge, ten and twelve circuits on two towers with connecting bridge and twelve and fourteen circuits on three towers with connecting bridges.

All of the above have been built with suspension towers and 0-, 45- and 90-deg. anchor towers. It is also now being considered to combine two circuits of 66 kv. with one circuit of 220 kv. on the same structure, this being considered because of the restriction of right-of-way, which is already occupied by 220-kv. circuits.

The steel for the structures was galvanized after all fabrication had been completed and was bolted together with galvanized bolts. Where earth conditions seemed to show alkali or other elements dangerous to steel the footings were treated with asphaltic paint in addition to the galvanizing.

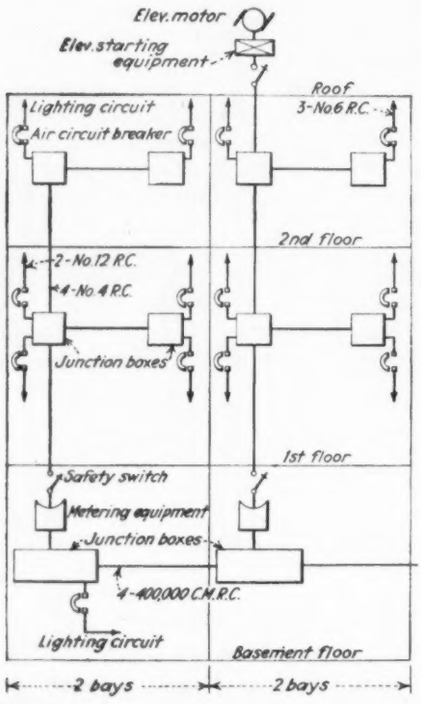
In the time during which these structures have been in use nothing has developed to disprove their utility.



Three-Phase, Four-Wire Reduced Building Wiring Cost

IN DESIGNING the wiring layout for the Providence (R. I.) Terminal Produce Market, the engineering firm of Jenks & Ballou utilized three-phase, four-wire distribution instead of the ordinary three-wire, 110-220-volt system.

E. Gray, president of Gray's Engineering & Electrical Construction Company of that city, states that had this job been executed along the lines of common distribution practice the cost would have been about 20 per cent, or $2,000 more than was actually incurred. As installed, the terminal market wiring scheme is as follows:



One-Line Diagram of Two Bays of Three-Phase Four-Wire Distribution in Public Market

The building consists of two stories and a basement, reinforced concrete construction being used. Three-phase, four-wire underground entrance feeders energized by the Narragansett Electric Company terminate in a basement junction box from which sub-feeder conduit lines are run to basement junction boxes serving as primary distributing centers for the various groups of bays into which the building is divided. Three-phase, four-wire risers lead from these junction boxes through metering equipment and safety switches to junction boxes on the several floors, and from each junction box the service of each tenant is supplied through air circuit breakers and distributing circuits for light and power as required. The four-wire circuit is carried through to the top story, but the grounded neutral stops at this point, leaving a three-wire, three-phase supply which is carried on to pent house elevator motors on the roof. Branch lighting service on the premises of the tenants is supplied through 120-volt, two-wire circuits without fuses and utilizing the neutral as one leg. All power service is at 208 volts. Permanent rigid conduit lines were provided through partition walls between bays to enable tenants to expand their utilized area and service at will. The elimination of separate risers for light and power was accompanied by a corresponding simplification of the junction box and metering installation. There are 209 lighting circuits. The building is 965 ft. long, 90 ft. wide and 32 ft. high, the connected lighting load being 195 kw. and the connected power load 62 hp. (ultimate capacity of layout 300 hp).

The Changing Pattern of Distributed Investment

THE rapid growth of the electrical industry in magnitude of output and in area served has resulted in marked change in the proportions of the total plant investment devoted to its various components. When loads and territory were small, the power plant investment represented a major portion of the capital requirements for plant and the distribution system was relatively unimportant. Higher distribution voltages enlarged the area served from a single plant and the ratio of distribution system costs to the total plant cost moved toward larger values. Still higher voltages injected transmission into the picture and still further decreased the ruling importance of the power plant investment.

The result is that whereas power plants once represented half or more of the total physical requirements for capital, now the combined value of plants and transmission are roughly equal to the value of the scattered distribution facilities on some systems. When power station investments were the determining factor in capital needs, it was natural that engineering talent should have been devoted assiduously to keeping initial costs and operating costs to a low level. This disposition was aided by the concentrated and co-ordinated nature of the problem. Further than this, it was primarily the electrical and thermodynamic engineers who were involved and for them it was a compact, definite and large-scale problem demanding a solution.

When transmission became an essential component of the electric system it likewise received direct and aggressive attention, with the result that costs of transmission lines have been kept from rising in keeping with general price levels. Again, the effort received aid from the inherently unified nature of that part of the system. Within the limits of topography the transmission line lends itself well to standardization as to tower design and spacing; the predominant use of right-of-way instead of highways eliminates all the grief that comes from rebuilding and relocating of highways, matching property lines, dodging trees, etc.

Somewhat later the substation loomed large in importance and when, at the same time, it loomed large in variety, attention was focussed on it. We have had in the last year or two considerable evidence of more economical design of substations of all types. Outdoor installation saves the cost of building housing and simplified circuit arrangement eliminates some of the protective and accessory equipment previously considered indispensable to the required degree of service continuity and reliability.

In the meantime what has been happening to the primary and secondary distribution systems? The total cost has, of course, gone up as the area covered made it multiply to the point of exceeding the cost of all the rest of the system. But the significant and somewhat distressing thing is that the cost per existing customer is rising and the cost per new customer is rising at a tragic rate. Some executives appear to believe that it is due to a sort of extravagance of the distribution engineers and superintendents, others that it is a more or

less inevitable consequence of the obstacles to economy presented by the very nature of the distribution system. A dozen factors can be cited which serve as an alibi for those who spend company funds in this department.

Among these items is the fact that jobs in distribution building are usually small jobs and jobs for which no long range planning or rigid organization can be effective. Much of the construction is urgent and therefore destructive of framed programs. Highway improvements necessitate reconstruction and relocation and often a plant sacrifice of overhead value when underground is forced. The activities of other wire-using utilities interfere with a 100 per cent unified and methodical handling of distribution construction.

On the whole, it is not strange that distribution systems have grown like Topsy and that lately the costs have shown a disposition to ascend like Eva. In fact, one of the Eastern companies reports the following experience with respect to system operating costs. The investment costs are taking the same general trend.

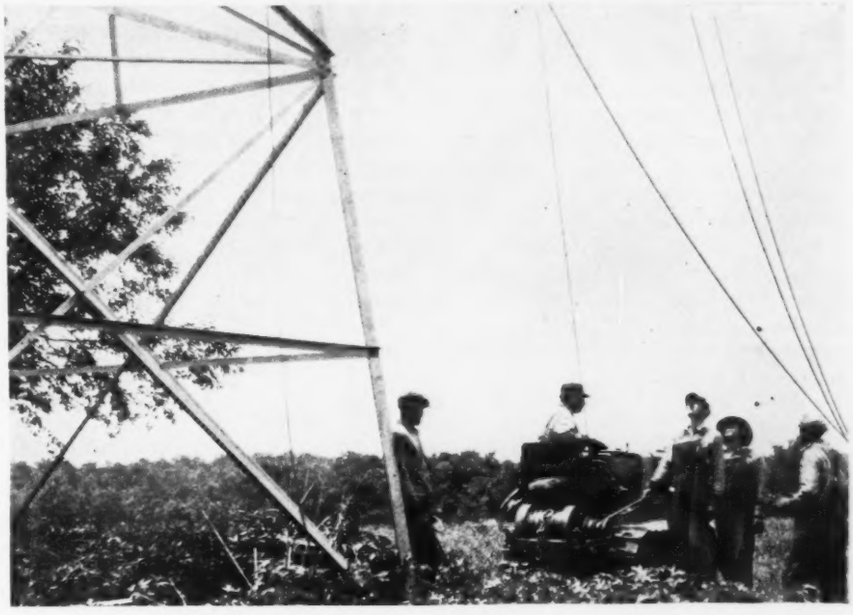
Operating Costs Rise Rapidly as Customers Increase

Year	Total Expense, per Cent	Expense per Customer, per Cent	Expense per Additional Customer, per Cent	Number of Customer
1926	100	100	...	52,459
1927	112	103	135	56,939
1928	135	113	219	62,612

These figures cover transmission, distribution, utilization, commercial and new business. The transmission component actually increased and the largest share of the increase was attributable to distribution and new business.

The distressing figure is, of course, the vertical rise in the cost of attaching new customers to the system, both in physical connection and in alignment as a customer. The newer customers are more remote and therefore call for longer extensions per customer. Likewise, the new-business department in order to justify the investment in the extension will have to induce an extended use of the service for appliances, cooking, refrigeration, water heating, etc. All of these are likely to overemphasize the importance of 100 per cent reliability of service. It is unfortunate that the very customers for whom the costs should be kept down demand such a high degree of service.

Caterpillar Tractor for Stringing Cable



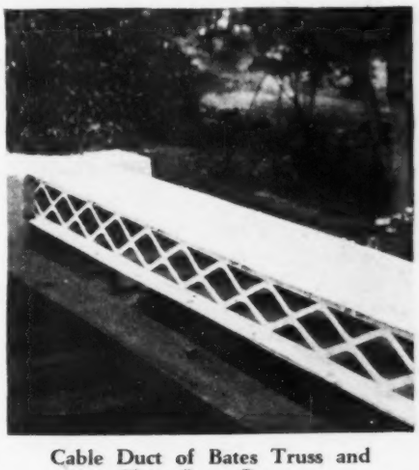
The Winch Does Not Require a Tackle Anchorage at the Base of the Tower, but Takes a Straight Pull

WHEN installing the second circuit of 477,000-circ. mil A.C.S.R. on a 70-mile 132-kv. steel tower line on the Illinois Power & Light Company system it was decided to try out a tractor on the job. At first it was not clearly apparent that the final cost of the job would be materially lower than with horses. However, that proved to be the case, and the tractor has established itself for major jobs of this kind.

It was found that the tractor could take out the conductors to a greater distance on a single pull than could horses. This saved much time. Also, by the use of the horizontal winch at the back, the tractor could lift the conductors up to the insulators on a straight pull without the necessity for a tackle anchorage at the base of the tower. The number of men employed was less than when horses have been used, due largely to the increased speed, power and dependability of the tractors. Any good truck driver, crane operator or farmer's boy who has driven his father's farm tractor quickly becomes proficient in handling tractors.

Exposed Cable Duct on Railroad Bridge

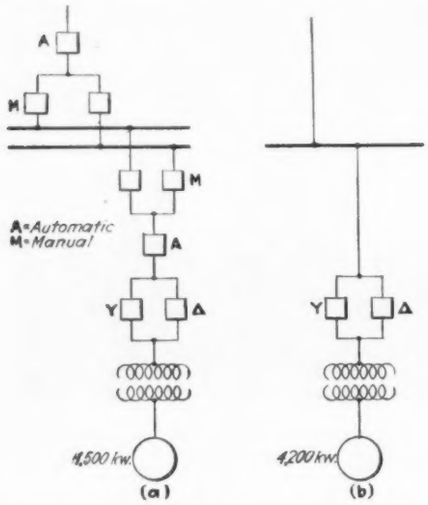
TO CARRY a 22-kv., lead-covered, paper-insulated, three-phase, 250,000-circ.mil cable across a country highway along a railroad right-of-way on a bridge without deck space in excess of that required for the tracks, the Eastern Massachusetts Electric Company utilized a Bates expanded metal truss design as shown above. The span was 27 ft. and the width of the structure 24 in. with a depth of 12 in. On the interior 2-in. x 3-in. wooden spacers were placed on the bottom 2 ft. apart to support the cable. The cover was bolted to the upper side members. The structure provides space for a second cable. It is planned to drill holes in the bottom plates to insure complete drainage. The truss design gives exceptionally good ventilation at each side of the structure.



Cable Duct of Bates Truss and Sheet Iron Covers

Simplicity in D.C. Substations

FORMERLY one large Eastern company built d.c. substations for 1,000-kw. to 1,500-kw. units in accordance with (a) in the accompanying diagram. The growth in



load has increased both the size and number of units so that it is felt that a duplicate or auxiliary bus would be superfluous. At the same time the number of circuit breakers has been decreased from eight to two by making the Y-Δ starting units serve the function of automatic protection. Each unit is served by an independent feeder, as shown in (b).

Long-Span Joint Construction

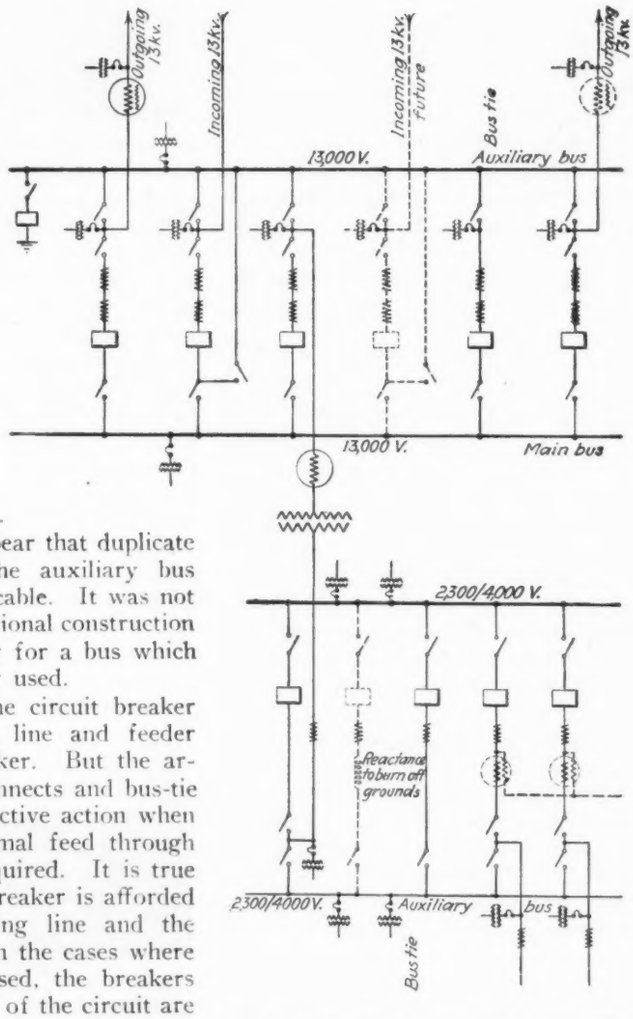
RURAL telephone lines, in which alternate poles have been replaced with 35-ft. members, have been overbuilt by the Syracuse Lighting Company in extending electric service to rural communities. This construction, says Minot H. Pratt, provides a minimum 6-ft. clearance between lines in the middle of the span providing the telephone poles are the usual short type and the tree conditions do not necessitate the use of tree wire in the primary. In making use of an existing electric line of 300-ft. sections, it is customary for the telephone company to set intervening poles of equal height for electric light and power company purposes. The communication company will use copper conductors up to 190 ft. and under unusual conditions special conductors are employed up to 250 ft., but the 150-ft. span is preferable.

In order to realize fully the economies derived from A.C.S.R. construction it is necessary to employ spans of not less than 300 ft., and when rural telephone lines are overbuilt the use of 40-ft. alternate poles by the power company is considered the best policy, since the greatly improved clearance, and hence the reduction in interference and hazard, offsets the relatively small additional cost.

Compared with sole ownership lines of 300-ft. spans there is no economy to the power company in having the telephone company set an intermediate pole. Although it is about 2 per cent more expensive, this form of construction is used occasionally to permit both companies to use the same side of the road where construction difficulties, such as trees and corners, would be encountered on the other side. The power company saves about 8 per cent when 190-ft. spans are used. The greatest economy, however, results in the use of 250-ft. spans and joint construction. It is about 20 per cent less expensive.

Flexible Switching Without Selector Breakers

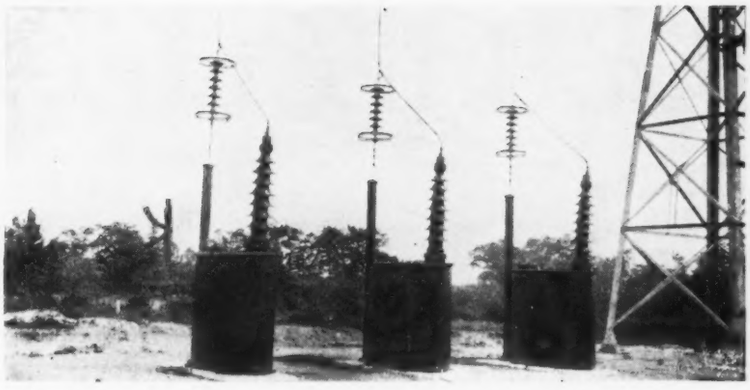
WHERE the nature of a distribution system is such as not to require the last degree of reliability of service, and will not economically justify duplicate buses, selector oil breakers, etc., the arrangement shown has been found to permit very flexible operation and still save investment in circuit breakers and duplicate buses.



While it may appear that duplicate buses are used, the auxiliary bus merely consists of cable. It was not felt that the conventional construction should be necessary for a bus which is only infrequently used.

There is only one circuit breaker for each incoming line and feeder plus a bus-tie breaker. But the arrangement of disconnects and bus-tie breaker affords selective action when other than the normal feed through the main bus is required. It is true that no oil circuit breaker is afforded between an incoming line and the auxiliary bus, but in the cases where this expedient is used, the breakers at the opposite ends of the circuit are relied upon for protection.

As may be observed, the normal circuit is from the incoming line through its oil circuit breaker and isolating switches to the main bus, and then out through the feeder circuit breaker with its isolating switches. In case the incoming line breaker is out for repair or inspection, the circuit to a feeder will be established back through transfer bus to bus-tie breaker to main bus and then the normal path. Or if a feeder breaker is out for any reason, the feeder is connected to the transfer bus, back through the bus-tie breaker to the main bus. A variety of situations can be handled with this arrangement which is used by an Eastern company.



Direct Wiring to Bus "Pots" Saves Material

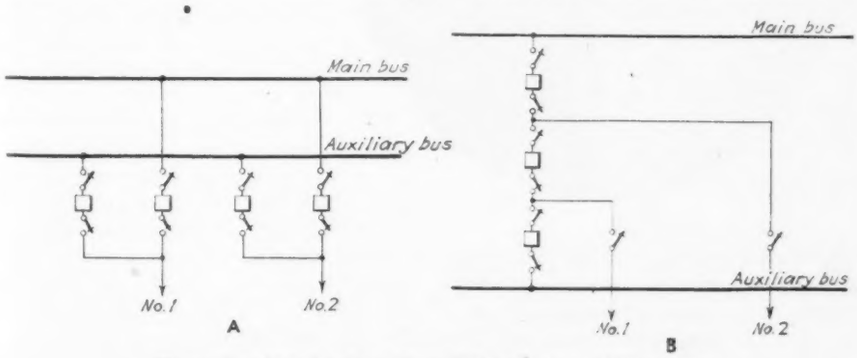
ECONOMICAL use of wiring material in connection with a bank bus potential transformer was achieved in a New England Power Association substation now under construction by carrying the taps from the three phases directly downward to strain insulators attached at their lower ends to spiral springs incased in 6-in. pipes fastened in turn to the transformer casings. A minimum spacing of 10 ft. between conductors was provided for the 110-kv. circuit concerned. From the connection at the top of each strain insulator a lead was run to the transformer bushing as shown, the secondaries being Y-connected to a grounded neutral elsewhere on the premises through three low-tension two-wire cables run in appropriate conduits to the operating building.

The spring which is installed inside the pipe on each transformer casing permits a vertical play of from 2 to 3 in. to overcome the variations in bus sag due to temperature or other causes. Further adjustment of tension in the taps is obtained when necessary by turnbuckles in the mechanical ties between the dead-end insulators and the spring anchorage.

Using 1.5 Breakers per Line

HIGH-TENSION switching stations are often designed with duplicate buses to permit the switching of feeders from either bus by interlocked selectors. When the character of the load requires the use of an oil circuit breaker for connecting the line to either bus, a substantial saving has been made on a number of systems by adopting the so-called "1.5 switching scheme."

The ordinary method of switching is shown in *A*, two oil breakers being required for one line, or a total of four breakers for the two lines. In *B* the main connections are shown with but three breakers used for the two lines. The middle breaker serves to throw the lines on either bus or the lines may be separated and supplied from independent buses if desired, leaving the middle breaker out of circuit. The number of disconnecting switches is the same in each case. This method is used by several New England companies.

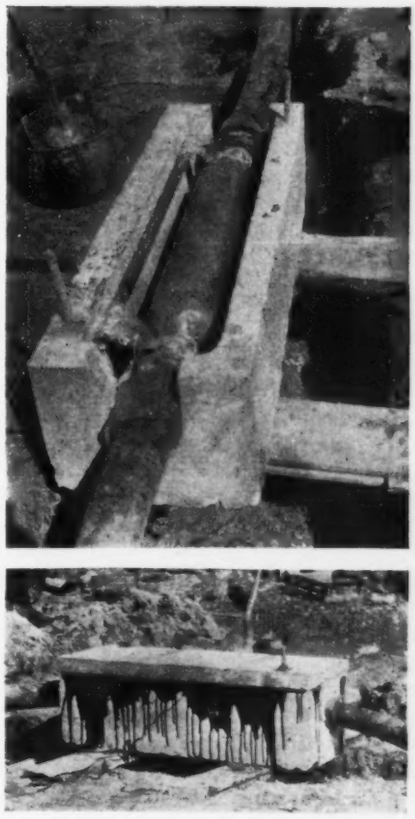


Three Breakers Replace Four Without Loss of Flexibility

Home-Made Junction Box Met Emergency

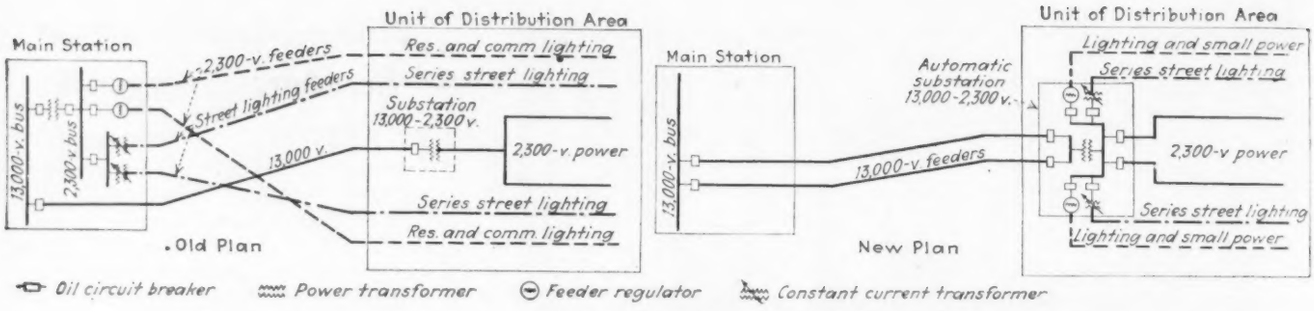
IN LAYING a 22-kv., jute-covered, armored cable an Eastern transmission company found that the diameter of a short submarine section was 1 in. greater than that of the trench section adjoining, the circuit being a three-phase, 250,000-circ.mil run of cable.

The standard junction boxes used on this job were purchased for the land section only and did not fit the larger section. To avoid the time required to obtain a special box to fit the two sections the construction engineer on the job designed a reinforced concrete box 4 ft. long and about 15 in. square, with bolted cover, in which the joint between the two sections was made up in the customary manner, the openings sealed and the box placed in the trench and backfilled.



Junction Box Before and After Closing Prior to Trenching

The work occasioned by this emergency was done in two days in order to get the line into service quickly, but the construction force reported that several times this period might have been required had other methods been utilized.



Better Service and Marked Economies Have Resulted from Simplification of Distribution System

Decentralized Distribution Cuts Investment

RADIAL distribution from main generating stations on the Pawtucket division of the Blackstone Valley Gas & Electric Company has been superseded by a plan of decentralized distribution in which unit automatic substations supply the varied service requirements of local areas formerly at arm's length, electrically speaking, says F. W. Smith, electrical engineer.

Previous to decentralization the distribution system consisted of radial 13-kv. feeders serving the larger power customers and three substations from which 2,300-volt feeders supplied smaller power users. All lighting feeders were single-phase, 2,300-volt regulated lines run from the main stations, and the series lighting service was similarly provided.

The present plan provides for 13-kv. feeders only to the substations, the standard arrangement comprising a preferential line and a normally open auxiliary line which automatically assumes the load in case of trouble on the former, street lighting, power and commercial lighting being supplied to the local area from the secondary side of the substation transformer installation. The two schemes are shown in the one-line diagram above.

Among the advantages are better regulation with increasing loads, simplification of the distribution system, reduction of distribution losses through shortening of feeder mains, removal of many miles of street-lighting circuits from the highways and the saving of a capital investment of about $200,000 in the representative case of constructing three automatic substations supplying 6,240 kva. of substation feeder capacity. Satisfactory voltage regulation was obtainable up to a maximum of only about 4,000 ft. with the former radial feeder plan, whereas under the new arrangement the service requirements of the entire Pawtucket-Central Falls district are being effectively and economically met.

Automatic control was selected for the substations in the revised scheme on account of its good record for reliability and lesser costs as compared with supervisory control. The automatic throw-over to the emergency 13-kv. line is effected in from 40 to 60 cycles, and upon removal of the trouble the restoration of the original line is automatic. All outgoing feeders from the substations are equipped with automatic reclosing breakers, and in 90 per cent of the troubles the feeder returns to service.

As line troubles usually cause most of the interruptions, the use of substantial construction and first-class material in the substations greatly safeguards substation service.

Service Pipes Installed Without Excavating

Air-Driven Coal Drill Starts Hole for Service Pipe

Service Pipe Driven Toward Curb by Air Hammer

AIR compressor equipment adapted for pavement removal and excavation of service trenches is used by one of the Greater New York companies in order to avoid cutting sidewalks and areaways or disturbing lawns when service pipes must be installed.

The service pipe is driven by air hammer from the cellar to the desired curb-line point on the street, where it is connected to the service Ys previously left in the pump-log service longitudinal. The air apparatus first cuts the cellar wall, then starts 8 or 10 ft. of hole with a coal drill and finally air-drives the service pipe the rest of the distance.

Reduced Power Costs?

Experienced power engineers answer sixteen questions on fuel-burning station economics and trends. Hopeful for future savings

By L. W. W. Morrow
Editor "Electrical World"

WILL it be possible to reduce the cost of electric power produced in fuel-burning power plants installed on utility systems? A group of experienced engineers answered this and other questions submitted by the ELECTRICAL WORLD. Both these engineers and the editors realize the difficulty in asking and answering specific questions because of the complexity of the subject and the modifying effect of local conditions so that these answers should not be used to deduce positive and generalized conclusions; they give merely a cross-section of current opinion as it exists among those most experienced in power station design and operation.

Power station engineers have accomplished marvels in recent years as regards improved thermal efficiency in stations and as regards a reduction in the total cost of power. They have made possible the rapid extension of utility service and the production of power in unlimited quantity. Can they continue the pace and help to reduce the system costs per unit of energy sold?

Power cost reductions involve a system economic analysis as well as an analysis of a single station. It is in the group design and operation of stations that lie the greatest opportunity for present savings. System developments are along the line of better load and capacity factors and greater service reliability.

During the six-year period 1922 to 1928 the national capacity factor changed from 27.7 to 32—a remarkable improvement—but there remains much to be done. For the past fifteen years the investment cost of fuel-burning stations per kilowatt of installed capacity has averaged about $100 and there appears to be little chance to change this average greatly in the next few years. But the present range is from $65 to $240 and, despite local modifying factors, it is the endeavor of power station engineers to reduce this range and to use the best design possible in a new station.

Also it should not be forgotten that service standards are increasing and govern power costs very largely. Very often this works against the economic solution of the system power cost problem. And there remains a speculative realm in which new developments must be gaged and measured as to possibilities. But, after all these things are considered, there is a reasonable conclusion that the cost of power produced by fuel-burning stations can and will be reduced 5 to 10 per cent in the next five or six years.

Question No. 1

Do you believe it will be possible to reduce appreciably the investment cost of new stations built in the next few years, as compared to that of stations recently constructed?

1. I believe that the cost of generating stations can be decreased by installing larger turbines, larger boilers operated at higher ratings, and by building a complete station of several units in place of one or two, as is common at the present time.

2. It will be difficult to obtain any material reduction in view of the increasing complexity of equipment.

3. Where the site is favorable and the cost of real estate is low, I believe material reductions in investment cost can be made.

4. Yes.

5. No, not in next few years.

6. There is no indication that the cost of materials, machinery or labor will be reduced within the next few years. The unit cost of stations has already been reduced due to the introduction of large units. Using this as a base, a further reduction is probable due to less expensive electrical equipment and a tendency to general simplicity.

7. I believe the cost of the higher pressure types of equipment will tend to decrease as the quantity production increases. I also believe the tendency is toward simpler stations, which should also tend to decrease the investment cost.

8. No.

9. No.

10. If turbines, boilers, fuel-burning equipment, piping and heat balance layouts, etc., as now developed are used in future stations so that development costs will not be a part of the cost of the future stations there should be a reduction in investment costs.

11. Assuming similar conditions dictated

by public policy, I do not believe it will be possible to decrease the cost of the stations appreciably. I do feel that there cannot be as much change in pressure and cycle in the next ten years as there has in the past and that a certain amount of standardization may be possible which might possibly reduce costs by 5 per cent. I do think that our utility companies must revise their ideas of power plant construction, with a greater emphasis upon capital costs and less emphasis upon the so-called public policy features, which frequently have called for what have seemed to me to be unwarranted types of building design and construction.

12. The investment cost for new stations for any given company will be affected primarily by the cost of equipment and other material and the rate of wages paid for the given locality, except so far as the given company may modify its own previous standards of requirements.

13. With labor costs remaining the same, there should be no material reduction.

14. I believe that we must, and therefore will, appreciably reduce the investment cost of new stations built in the next few years as compared with that of stations recently constructed.

15. I believe it will be possible to reduce the investment cost per kilowatt of the new stations built in the next few years.

16. I believe it is possible to reduce the investment cost of new steam power stations by a more thorough appreciation on the part of the designing engineer of the factors governing the design and their relative importance as affecting investment cost and operating efficiency. There are some factors beyond the control of the designer, once the location is selected, that may affect materially the construction cost, but aside from these the best and most economical design will be obtained by the person or organization who through experience is able to view the subject broadly and determine the proper relation of each component part to the whole. The type and size of building, sizes of units selected, provision of spares and for reliability of service affect materially the ultimate investment cost.

17. The cost of stations recently constructed varies widely as determined by: (a) Type of stations; (b) skill of designers; (c) skill of purchasing agent; (d) skill of constructing agent, and (e) extent to which equipment still under development is incorporated. Reply to your question must take cognizance of these factors in addition to the possible purchasing ability of money.

It appears probable that the purchasing ability of money will increase slightly in the future. This indicates a slight decrease in the cost of stations of given type.

Stations which incorporate high-pressure and high-temperature equipment are now paying high development cost, which it is reasonable to suppose will be amortized in the very near future. This indicates a reduction in the cost of such stations.

Station designers and station constructors are acquiring greater skill daily. This fact, combined with the definite demand of executives for cheaper plants, will undoubtedly result in a reduction of cost of given types of stations.

Excepting for any possible increased purchasing power of the dollar and decreased cost of high-pressure and high-temperature equipment through amortization of development changes, I do not believe there will be any great reduction in the cost of stations of given type. The word type refers not only to steam pressure and temperature, kind of heat balance and things of that sort but also to size of boiler unit and size of turbine unit. By great reduction I mean something of the order of $10 per unit of capacity.

18. I believe it entirely possible to bring about an appreciable reduction in the investment cost of new stations built in the next few years as compared to that of stations recently constructed.

Several points of attack are open to bring this about, such as: (a) Putting a portion or even the entire station outdoors; (b) cutting out many of the spare or duplicating features; (c) saving in architectural cost.

Comments and Conclusions

An equal division of opinion exists as to the possibility of a reduction in investment costs. It will depend on the practical outcome of some present semi-experimental installations as regards an individual station and will depend largely on service standards and developments in transmission and distribution as regards a system as a whole. For example, to give the highest grade service a transmission system must have generating sources at intervals of 20 to 50 miles. Another example is the development of the a.-c. network and synchronized-at-the-load operation for metropolitan systems. A reasonable expectation is a 5 to 10 per cent reduction in investment charges in the next five years.

Question No. 2

Do you believe it will be economical to rehabilitate older generating stations as compared to building new ones?

1. The question of rehabilitating old generating stations depends greatly on local conditions and I find it difficult to give a general answer. Where sites are plentiful and cheap, and a new station can be located so that little additional transmission line expense is necessary, I tend to favor the building of new plants until we are justified in making a complete overhauling of the situation. Where land values are high and sites are difficult to obtain this condition is reached in a considerably shorter period than under more favorable conditions.

2. In many cases, yes.

3. In answering this it is assumed the cost of fuel f.o.b. the plant is the same for the old and new stations. At this time the rehabilitation of the old station increasing its capacity from 50 per cent to 100 per cent, and at the same time improving economy, results in better economics than building the same added capacity in a new station. One governing factor is that usually the older station is already placed advantageously, serving a market, and the new available location has a greater cost in delivered power because of duplication of feeder facilities.

4. Yes.

5. In some cases, yes.

6. Generally it is economical to rehabilitate an older station if it is advantageously placed.

7. I do not believe any general answer is possible. It all depends upon the conditions in each individual case. Real estate values, usability of the old buildings, value of proximity to the load center, etc., all enter into it.

8. Relatively seldom.

9. No.

10. This is entirely a question of the amount of space available in the old station, the condition and characteristics of its equipment, and the loading proposed.

11. In perhaps 15 or 20 per cent of instances it will be possible to rehabilitate older generating stations and more economical to do so than to build new ones. In the majority of instances, however, some condition, such as water, depreciation of building, or foundation of buildings, or transmission and distribution problems, makes it difficult, and frequently impossible, to make over and increase the size of old stations.

12. If an old plant is favorably located and it is possible to spare its capacity long enough to make major changes it may be economical to rebuild the plant. On the other hand, with rapidly increasing system loads and the ability to find other plant locations equally favorably situated with respect to load, condensing water and coal supply, it may be more economical to build the new plant and continue to use the old plant as a reserve and on the peak of the system load.

13. This is a local problem and depends on the plant in question.

14. The answer to this question is a matter of fact and not one of opinion. In general, for stations with high load factor, output and high fuel cost, it probably will not pay to rehabilitate old stations. On the other hand, where capacity rather than economy is a governing factor, it may prove economical.

15. In general I do not believe it will be economical to rehabilitate the older generating stations as long as new capacity is continually required to meet the demands of a growing load. The older stations can be used for standby or emergency capacity at a comparatively small total cost of operation which practically prevents the elimination of this capacity from the system and its replacement by new capacity.

16. It depends on how old the generating stations are and how conservatively they have been designed. The work recently done at the West End and Columbia stations in Cincinnati are examples of economical rehabilitation, even though the efficiency of the Columbia station was decreased slightly thereby. In a case such as this rehabilitation may prove economical, but in most cases this situation does not exist. Then it generally works out that the older stations are operated on the peak load and newer ones are built to take the base load.

17. It is my personal belief that we are approaching the time when it will be found economical to rehabilitate many of the older stations in preference to the building of new ones.

18. In general, I believe yes. The problem, however, is very much tied up with two main system considerations, these being: (a) Location of the particular station with regard to load; (b) the location

of the particular station with regard to the transmission system, where a transmission system is in existence.

In general, if the above are taken into consideration, I believe it will be found practicable and economical to rebuild stations, whereas the same result might not be obtained if these two factors are disregarded.

Comments and Conclusions

Despite the many qualifying clauses in the replies it is reasonable to assume that it is worth while to analyze the possibilities of rehabilitating stations ten to fifteen years old. An appreciable percentage of these old stations can be rehabilitated economically, especially those whose original cost has been pretty well amortized and located at a good site in a load center.

Question No. 3

Do you believe it economical to superimpose a high-pressure installation on an older low-pressure station?

1. I have not made a detailed study of the cost and advantages of 1,200-lb. plants, but I believe that if the 1,200-lb. plant cannot be built with as much output from the turbines and boilers as the 400-lb. unit, even with fairly high-priced coal, the 400-lb. unit will be the most economical.

2. Yes.

3. It is only economical to superimpose a high-pressure installation on an older low-pressure station of fifteen or twenty years ago; that is, one in which the boiler room investment is well amortized.

4. Very questionable.

5. In relatively few cases, yes.

6. With an available base load, even though small compared to the peak, it should be economical to superimpose high pressure to some extent.

7. Much the same as Question No. 2, except that, in general, I think the probabilities are in favor of superimposing a high-pressure installation on a low-pressure station.

8. Yes, but not often.

9. A small percentage of high pressure to carry base load which must be distributed from an old station will in some cases prove economical.

10. In general, I believe the 200-lb. nonbleed stations can be greatly improved by superimposing a high-pressure installation, providing space is available for new boilers and turbines.

11. Where load factors and distribution conditions will permit, I feel sure that it will be economical to superimpose high-pressure installations on older low-pressure stations.

12. This is a problem which must be worked out for every individual case. It depends somewhat upon the original characteristics of the low-pressure installation and also principally upon the increased fixed charges which will result. In studies which we have made, the situation does not appear very attractive, as the fixed charges are rather high and it would involve changing the station operation from a good peak-load station into a so-called base-load station for most of the equipment.

13. Yes, if the older low-pressure system is in good condition.

14. In some, but not by any means all, cases the superimposing of a high-pressure installation on a modern low-pressure station may prove economical. In some studies recently made it appears that the addition of a high-pressure unit to a station twenty years old is not economical, whereas its addition to a station only five years old does prove economical.

15. I believe there are many cases in which it may be economical to superimpose a high-pressure installation on an older low-pressure station. This, however, depends upon the layout of the station and the relative capacity of the station as compared to the system load.

16. This may prove out in some cases, but as a rule I believe it will be more economical to reserve the older stations for the low load factor load. Raising pressure to 1,200 lb. means rebuilding boiler plants completely and scrapping investment that is good for peak capacity. I believe that the net result will not show this to be of advantage except possibly in a few and special cases.

17. The method suggested represents one of the simplest means of rehabilitating and it appears to have many economic advantages. In other words, it appears to give both increased capacity and increased thermal efficiency with a comparatively small expenditure of dollars.

18. It may be possible in many instances economically to superimpose a high-pressure installation on an older low-pressure station; in fact, it may be the only economical way of bringing about this result.

Comments and Conclusions

It is very doubtful if a large percentage of existing low-pressure stations will superimpose a high-pressure installation. This type of installation may be said to be still on trial economically and under some development technically. It has a field of application that appears to be rather restricted.

Question No. 4

Do you believe it will be economical to build new stations for 1,200-lb., 800-deg. conditions?

1. See answer to Question No. 3.

2. Yes.

3. It will be economical to build new stations for 1,200 lb., 800-deg. F. conditions and even higher pressures.

4. Yes.

5. Yes, if the annual load factor is very good and the fuel not too much cheaper per 1,000,000 B.t.u.

6. The matter of the advisability of 1,200-lb. pressure is still in doubt, but the temperature of 800 deg. should be economical.

7. I do not believe the question of economy in first cost will in all cases be the deciding factor. Sometimes a limited quantity of condensing water available will make it advisable to put in a plant capable of generating the maximum amount of power possible with a given quantity of condensing water. Temperature of condensing water would also come into this problem. The higher the condensing water temperature the higher your pressure should be in order to develop the maximum power. With a high load factor the trend seems to be toward the higher pressure stations.

8. Yes, for relatively high fuel costs and load factors.

9. In some cases it will be economical for a base load station to be 1,200 lb., 800 deg.

10. I have not sufficient data to answer this. When the equipment for 1,200-lb. and 800-deg. conditions has been standardized and sufficient load is available to run it nearly continuously it may be economical. At present the newer stations require a plant factor between 50 per cent and 70 per cent before the carrying charges are as low as the operating charges per kilowatt-hour. On the older stations the carrying charges equal the production charges at around 20 per cent plant factor. At 50 per cent plant factor the total cost of a kilowatt-hour of an old station is 0.9 cent, for a new station 0.7 cent. At 33 per cent plant factor the new station shows 0.9 cent total. The foregoing shows the effect of investment charges on over-all costs, as the old station does about 28,000 B.t.u. and the new station about 16,000 B.t.u.

11. I very seriously doubt if more than 10 or 15 per cent of our new capacity in the next few years will be built for 1,200 lb., 800 deg. Rather I expect 600 lb. and 900 deg. to be the most economical.

12. This has yet to be proved, as none has actually as yet been built, although there are at least three to my knowledge now under construction, the owners of which have apparently satisfied themselves with its economy. These are the first stations that have no low-pressure boilers with which to keep the greater part of the turbine capacity in service during outage of the high-pressure equipment.

13. Yes.

14. Yes, except that I would offer the further suggestion that perhaps 1,200 lb. will, in a few years, be considered a low pressure.

15. Yes.

16. I believe that 1,200-lb. stations are going to increase in number as the sizes of systems grow and as the cost of high-pressure equipment becomes less. We cannot hope, however, to build a 1,200-lb. station of a given capacity and for a given set of conditions as cheaply as we can a 450-lb. station of the same capacity. Economic conditions of load factor and cost of fuel must offset the additional fixed charges, which, however, are not so great as some people imagine. As to increasing steam temperatures to 800 deg. F. and higher, I think this is coming as soon as we are able to produce materials to stand the high temperature safely. When it does, I believe that some pressure, say 650 lb., can be used with the higher temperature which will avoid the necessity for reheating the steam and make a less costly installation, with most of the economic advantages of reheating. This, however, is a problem for each individual case.

17. As yet, I am not able to justify the

1,200-lb. station even at 800 deg. initial temperature except possibly for real base-load operation over a period of ten years. If one desires to exceed 400 to 500 lb. with the temperature limitation given it appears economical to jump directly to something of the order of 1,200 to 1,400 lb. rather than to stop at any intermediate pressure.

My own impression is that greater economic possibilities lie in radical increase of steam temperature and this company is acting on this belief in its experimental installation of a unit to operate at an initial temperature of 1,000 deg. F. I believe it will be found possible within the next few years to operate with an initial steam temperature of 1,000 deg. or higher; I am tentatively setting the limit at 1,200 deg. F.

18. Yes, most certainly. Nothing in our experience to date has indicated anything to the contrary. We are building 1,200-lb. stations and the economies are very much in favor of it and 800-deg. steam will most certainly come.

Comments and Conclusions

The majority opinion is in favor of the 1,200-lb., 800-deg. station as an economic development for rather extensive application. This decision is necessarily based on "paper" analyses, because a large station of this type is yet to go into service and accurate data are not available. Several are in progress now and others will follow, so that more tangible evidence will be afforded shortly to support the expert opinions. A reasonable expectation is that 10 to 15 per cent of new station capacity installed in the next two or three years will be of this type. There is a strong feeling, however, that a station of 450 to 600-lb. pressure and 800 to 900-deg. steam temperature may prove more economical and practical than the very high pressure plant.

Question No. 5

Do you believe it economical to project a building program for a large station in a series of steps or additions of large blocks, as compared to building a complete station unit for current needs and meeting later demands by building another complete station when and where desirable?

1. The building of power stations of large capacity may require several utilities dividing the output among them and is, of course, easier to handle where there is common financial control. The cost of transmission to interconnected stations and utilities has to be considered before determining the size of station which can be built at one time. In territories such as ours it is doubtful whether we are justified in building more transmission lines than are required to interconnect the stations and hold them in synchronism. For instance, today our stations are about 50 miles apart. If the load increases sufficiently, we can install additional power stations between, which will reduce the distance to one-half or even one-fourth of what it is at the present time, which will make a maximum transmission distance of 20 miles. This would give a cheaper layout and one from which better service could be obtained than if the territory were served from a single station.

2. Depends on load conditions.

3. It is more economical to project a building program for a large station in a series of large blocks, particularly if the site is advantageous as regards fuel and circulating water and is reasonably adjacent to the system load center. These sites are really scarce when it comes time to make a selection.

4. I do not understand the meaning of this question. At the present time we are providing in a station a comfortable space in the power house for changing equipment, choosing floor elevations, column centers, etc., which can easily accommodate two or three sizes of larger machines. We feel that we can do this without upsetting the unit system which we are planning; that is, use of a double row of boilers and turbines placed crosswise of the station, of such a design that both the boiler and turbine house can be kept the same length.

5. Transmission investment from suitable sites to power areas usually dictates a series of additions.

6. Other things being equal, it is better to build a large station in a series of steps. This, however, is influenced largely by the distribution problem, the changing character of the neighborhood and certain local conditions.

7. Above a certain point I doubt if any gain is made by building stations with very large total power capacity. A 400,000 or 500,000-kw. station, for instance, appears to have few advantages over two stations of half that capacity. The growing tendency toward the use of interconnected a.c. secondary networks, with the probable elimination of large buses at the stations and the substitution of feeders directly into the interconnected network at different points, will have a decided effect upon the station building program. With a wide-spread a.c. secondary network it would appear to be advantageous to feed this network from several 200,000 kw. stations rather than from one or two stations with 400,000 kw. or greater capacity.

8. The former in most cases.

9. A station should be built for current requirements only, so that every advantage can be taken of advances in the art. New sections or steps should be added to the station as the load increases.

10. The answer to this question depends on whether it is an urban or rural location, and more on the economics involved than the power plant problem. In general, I believe no single station should house more than 1,000,000 kw.

11. I believe it best to build complete station units with provision only for electrical tie-in, unified coal handling, office facilities and co-ordination of water supply and to take care of additional capacity at the site by building new station units, not necessarily of the same pressure or design conditions.

12. Yes. I believe, in general, it is more economical to build a new station in a series of steps, because as a rule, with the larger systems and the larger size units available, stations are being laid out for an ultimate number of units from 6 to 10, and the system would not be large enough to require a full installation in any one year.

13. Depends on the size and growth of the city. It is not economical to build a number of small plants at various locations. In the smaller cities it is good practice to build a single plant with the idea of extensions until the growth of the city or load conditions warrants building at another location.

14. Judging from our experience, it seems not only economical but necessary to project a building program in a series of steps rather than building complete station units from time to time.

15. Yes.

16. This, again, depends on the sizes of the steps and the concentration of capacity desirable at a given point. It is possible and economical to project a building program in steps that will not so tie down the design that advantage cannot be taken in succeeding steps of advances in the art that may have been made.

17. The answer to this question is bound up with local conditions to such a degree that it is impossible to give a categorical answer. In general, conditions are such that a station of economical size cannot be built at one time as part of a normally growing system. If such conditions exist the step-by-step construction is the most economical solution. Where a number of small systems have been combined under one management conditions may be quite different and the construction of one large station to take the place of a number of previously existing small ones may be economically justified.

18. I am not certain that this question is seriously meant. It seems to us that there must be something wrong with the system or with the planning where an entire station can be built at one time at a particular site unless the capacity of the site is almost negligible as compared to the size of the system. It ought to be possible, and we have actually done it, to build a station in a series of blocks or steps with the future steps or blocks projected. When the time for additional capacity comes, the question of duplication can again be considered, and then if it is more economical to duplicate, well and good; if not, the design ought to be so flexible that something new, if changes in the art indicate its desirability, is possible.

Comments and Conclusions

For some time it has been favored practice to build stations in a series of steps based on an original layout and often upon original substructure and design stipulations. The replies to this question indicate some difference of opinion as to the practice as compared to building each station or station unit when and where

needed and of a design up to date at the time it is built.

Many modifying factors are apparently injected into this problem, but in general it would seem advisable to make station units independent of each other as regards design periods and to eliminate all forced design because of original design stipulations and site construction. A series of station additions in steps is logical, but this can be done without introducing current design restrictions because of previous conditions or construction.

Question No. 6

Do you believe the economic limit for pressure, temperature and rating, if used, is beyond the limit fixed by maximum safety? Continuity in operation?

1. In any studies which we have made so far the economic limit has been higher than the practical limit at which the equipment should be operated.
2. No.
3. No to both.
4. No.
5. Yes, temporarily.
6. The economical limit is considerably beyond the safety limit of materials. Continuity of operation is also dependent upon the limit established by materials.
7. No.
8. No, practically speaking, although there is of course a slight reduction in safety and in continuity of operation by the adoption of higher steam conditions.
9. I believe that where high pressure and temperature are economical plants can be made safe and reliable.
10. High ratings and pressure I do not think "unsafe," but high temperature is still beyond the range of materials now available for safe use. High rating is decidedly a factor that interferes not only with continuity of service but also good efficiency.
11. At the present time the theoretical economic limit for pressure and temperature and rating is beyond the limit fixed by maximum safety and continuity of operation. As a matter of fact, the uncertainty of results from the extremely high pressure and temperature plants is the limiting factor in the minds of most designing engineers and is the reason for the experimental installations that are being installed.
12. I believe the economic limit for pressure, temperature and rating is controlled by maximum safety; that is, continuity of operation. An extreme rating of any item which carries a limiting factor as to the number of times or frequency as to which it may be used is not worth much, unless, of course, it so happens that this limiting number of times or frequency is very greatly in excess of the number of times such limit may be required in service. I think this may be compared to the fatigue limit in the strength of materials.
13. I believe the economic and safe limit at present is about 1,400 lb. and 800 deg. F. for continuous operation.
14. The continual development of materials has, up to the present, been keeping pace with the extension of steam pressures and temperatures as dictated by economic design. That this will continue is no doubt certain as concerns pressures; however, it would seem that the limit of safe temperatures has been approached.
15. I am not sure as to the intent of this question. With present known materials we are practically at the limit of the heat cycle that can be safely and economically used. It is possible, however, that new materials may appear on the market which will permit higher temperatures. It is very doubtful if higher pressures would be productive of much increase in economy since the fundamental efficiency of the heat cycle increases very little with increased pressures above 1,200 or 1,400 lb. The expectancy must be along increasing temperatures, rather than pressures, but the art of manufacturing materials for much higher temperatures has not progressed sufficiently to make their use at present practical.
16. I do not believe the economic limit for pressure is beyond the limit for maximum safety. Temperature is another thing. We can utilize higher temperatures economically, but materials must be developed to withstand them before we can safely go much beyond the present accepted limit of 750 deg. F. The same comments apply to continuity of operation as well as to safety.
17. I do not believe that I can answer this question in exactly the form in which it is asked. If the question is intended to ask whether investment and thermal performance would indicate higher pressure, temperature and rating than is now set by requirements of safety and continuity of operation I think the answer is "No." On the other hand, I believe that the acquisition of greater skill in the design and construction of high-temperature and high-pressure equipment will make it economically possible and desirable to operate with safety and reasonable continuity at pressures and temperatures which are now regarded as highly questionable.
18. In general, I do not believe that the economical limit for pressures, temperature and rating, if used, will be found beyond the limit fixed by maximum safety, if by safety is only meant safety to human life; nor do I believe that the first two factors will have a great bearing on continuity of operation. The question of rating size, of course, is another matter, and this has got to be considered from the standpoint of the system size. Obviously, a rating that would be way beyond the desirable maximum from a continuity service standpoint in a system of 200,000 kw. peak will not be beyond that in a system of, say, 1,000,000 kw. peak.

Comments and Conclusions

The diversity of opinion as to the safety and reliability of high-pressure and high-temperature installations is to be expected—the answers depend largely on the assumptions and data that fix the value of the economic pressure and temperature. There is no valid reason to expect much change in safety conditions if intelligent design is used, but no one can yet answer the continuity of operation questions except on an opinionative basis. It is reasonable to assume a slight reduction in availability factor because of more maintenance, but no proof exists that this is true now or will continue to be true when a greater degree of standardization in equipment and operation prevails.

Question No. 7

Is it possible to reduce the spare boilers, auxiliaries, turbines, transformers, buses and switches in plants on systems with many interconnections?

1. Yes. Such stations should be operated so that there is the least possibility of trouble from one section being communicated to an adjacent section and enough spare capacity should be carried on the interconnected system at all times to take care of the largest probable outage. I am doubtful if this involves more than about 10 per cent spare capacity on a big interconnected system. Most steam-generating equipment or turbines can be operated at 10 per cent above their normal maximum capacity for the period for which it is required to put additional capacity into service.
2. This depends on the system set-up. In general, yes.
3. Yes, materially.
4. Yes.
5. Yes.
6. In most cases it is possible.
7. It should be entirely practicable to reduce the equipment as you suggest.
8. Yes.
9. Yes, when the ties are reliable and sufficient.
11. It certainly is possible to reduce the number of spares of one kind or another on well-interconnected systems. A great many stations are still being built with entirely too many duplicate buses, switches, auxiliaries, transformers, etc. Some additional money spent on the things installed and the manner of their design would greatly enhance the reliability and make it further unnecessary for the spares and duplicates.
12. Yes, if the system interconnections are of such size that the capacity of the largest machine in any one system may be supplied to that system from other systems over the tie-lines; in other words, if the interconnections of the systems are so laid out that the several systems may be operated practically interchangeably as one large system.

13. Yes.

14. Unquestionably some economies in future plant costs will be secured by the elimination of some of the duplications of spare equipment both in main equipment and auxiliaries where advantage can be taken of the interconnection with other plants on large systems.

15. Yes.

16. I believe it is possible to reduce the spare equipment provided in a station, the extent depending, however, on the size of the station, type of system it is connected into, etc. Reliability of equipment is increasing and therefore the necessity for spares becomes less.

17. Yes.

18. By all means; that's what interconnections are for. If that is not done and the spare boilers, auxiliaries, turbines, transformers, etc., are not reduced in the various plants on the systems where interconnecting transmission lines exist, then interconnection ceases to be an economic help, but becomes an economic burden.

Comments and Conclusions

The consensus of opinion is that simplicity and reserve reductions should accompany interconnection. In theory, at least, a system can reduce its reserve capacity if well interconnected with other systems. In practice, however, this is not done very often or for a very long period. Each system maintains its normal reserve and the interconnection is an emergency reserve capacity that helps to raise service standards on a given system. In the present state of the transmission art every added line is a service hazard as well as a service improvement when the lightning begins to flash and, on most transmission systems at least, service standards still dictate a self-contained generating system with normal reserve. Service requirements and not economics will largely control the answer to this question in a given case.

Question No. 8

Do you believe it will be economical to use the recent methods for getting high boiler ratings in the design of large stations? (Well-type furnace at Buffalo—all-metal furnace in New York.)

1. I believe that the greatest reduction in power station costs would be made by increasing the amount of steam generated per unit, and this would depend upon getting high boiler ratings. Higher outputs can undoubtedly be obtained from powdered fuel than from stokers. However, there is a greater dust problem with powdered fuel than with stokers, and this will have to be solved before big powdered-fuel-fired stations can be installed in settled districts.

2. Yes.

3. Yes.

4. Yes.

5. Yes.

6. The water-cooled furnace has definitely proved effective in economically securing high boiler ratings. There is no doubt that some adaptation of a slagging furnace is also of value.

7. In the case of high-load-factor stations where the high investment costs are warranted by long-hour use, I believe the types of furnaces suggested are fully warranted.

8. Yes, and by the use of other similar methods.

9. Depends on local land and building costs. Where land and building construction is cheap, moderate or high ratings will cost about the same per pound of steam capacity.

10. Personally, I feel that the punishment given boilers at continuously high ratings is not desirable and I feel more is actually gained by lower rating operation, as the outages are reduced and the efficiency kept higher.

11. I believe it will be economical to obtain high ratings by use of present well type furnaces or the development of this idea so that we may expect a decreased fixed charge cost per kilowatt by reason of higher ratings rather than by reason of lower capital costs per kilowatt of rating.

12. The economical method of obtaining so-called high rating depends largely upon the type of load the boiler plant is required to carry; in other words, what is the rating at which the boiler plant will be required actually to operate day in and day out for a period of ten to twelve hours and what is it required to do for a one- to three-hour period?

13. Yes.

14. An appreciable element in reducing the investment cost per kilowatt of capacity is the obtaining of greater output per square foot of boiler heating surface. This requires greater heat liberation in the furnaces, which, in my opinion, can be obtained more economically with such furnaces, as those at Buffalo, N. Y., to which you refer.

15. Yes, with possibly some modification.

16. I believe that it is economical to use the modern methods for increasing capacities to be obtained from boilers. Steam generation in the past has been limited by the amount of fuel that could be burned in the furnace without excessive maintenance costs. Anything that will increase the ability to burn more fuel and so to obtain greater output should prove economical if properly co-ordinated with the other elements of the design.

17. I believe that the use of protected furnace walls as a means of obtaining high steam outputs from boiler units of given area is economically correct in central stations in which sufficiently skilled superintendence and personnel are available. This conclusion is intended to hold both for cases in which the station capacity factor is high and those in which the station capacity factor is low, but a marked peak must be carried.

Comments and Conclusions

Many engineers today are rather favorably inclined toward stations built on the unit principle, i.e., one boiler and one turbine. Nor are many doubtful of the practicability of using high boiler ratings and very large units. The majority opinion favors the high rated boiler and considers feasible and economical the water-cooled furnace. A recent order for a 250,000-lb.-of-steam-per-hour Benson boiler for a German power station is indicative of the rapid changes in the boiler art. The key to both capital and thermal gains in the boiler is the use of higher temperatures and experimental developments are promising even at 900 deg. and over. Through the use of high boiler ratings will come big reductions in capital costs per kilowatt, but operating and maintenance costs must be considered before making positive conclusions on over-all savings. At the present time the continuity of service element cannot be said to justify the use of high ratings to an extreme degree.

Question No. 9

In building new stations, do you believe the greatest opportunity for saving lies in design, construction or operation?

1. First, size of units installed; second, total capacity of a station installed at one time; third, simplification of design. I believe that most large modern central stations are operated so as to get the lowest over-all operating cost. A few are operated to get high efficiency irrespective of cost.

2. These items often work against each other. A saving in one may mean an increase in another, and vice versa. Judgment must be used in each case.

3. The greatest opportunity for saving is in design.

4. In all three.

5. Design.

6. Opportunities for savings are about equal in design and operation, considering the latter as including purchases, arrangements for coal deliveries, etc. There is considerably less opportunity in the matter of construction.

7. Principally in design and to a smaller degree in operation. I do not see that the construction comes into the question to any great extent, as it is determined almost entirely by the design.

8. In design, including choice of materials of construction; construction and

operating methods should improve, but not radically as compared with the best practice.

9. First, operation; second, design; third, construction.

10. Operation, because the station should be designed to comply with the expected operating requirements. It then requires a proper understanding of the operating problems of the station and the system to which it is interconnected to attain the objective of the design.

11. I believe in new stations the greatest opportunity for savings lies in design and operation; mostly in design. This statement, of course, assumes that the standard and well-known methods of construction are employed under the direction of competent construction men. There are a great many construction wastes in some central stations because of the mistaken idea that complete engineering is not necessary before construction.

12. The greatest opportunity lies in design and construction. The operators of a station cannot obtain better results than the designers put into it. They can only operate it up to the efficiency actually put into individual pieces of equipment.

13. In design. Without proper design operation could not be economical.

14. The "savings" outlined in your question I assume refer to investment cost. Undoubtedly the greatest opportunity lies in the design of the station, not only in the type and arrangement of equipment but in the simplification of the building and foundations.

15. I believe the greatest opportunity for savings in each station lies in the design and construction of each station rather than its operation.

16. I believe that the greatest opportunity for saving in building a new station lies in the proper analysis of the conditions under which it will operate and developing the design to meet these conditions. To design a station properly the engineer must have in mind also the effect of his design on cost and speed of construction.

17. Limiting the question to new stations, as you have done, I believe the greatest opportunity for savings lies in designing. Considering the stations throughout the country, both new and old, I believe the greatest opportunity for savings lies in operation.

18. It is obvious that the most vital factor in the determination of the operating cost of a steam station is the design of the station. If the station design is wrong, very little can be done subsequently, unless the station is redesigned in the way of getting decent operating economies. It does seem, however, that some more attention can be given in the design of stations to the operating set-up. In other words, very often a piece of apparatus can be put in that promises additional economies in the way of thermal cycles that requires perhaps an additional man to take care of, and that additional man may be more than sufficient to counterbalance all the thermal economies obtained.

Comments and Conclusions

Of course any very large savings in power station costs must come through radical changes in design. Construction and operation offer opportunities for savings on a comparatively small scale. But with the present standardized equipment and art it would seem each item is about on a par and no very marked savings can be made. Design is efficient as well as construction and operation. Possibly the largest savings can be made through studies of design and operating economies, considering all stations on a property from the point of view of minimum cost of power to the system as a whole.

Question No. 10

Along what specific lines lie the greatest opportunity for savings in the design of steam power stations?

1. At the present time the greatest opportunity for reduction in cost is in increasing the output and decreasing the investment in steam-generating equipment.

2. Increased steam pressures and temperatures and increased size of units, or the adoption of some binary cycle.

3. Where there is not a great change in circulating water supply level and adequate real estate at low cost is to be had, some changes in the design of apparatus and a complete outdoor installation of boiler and engine room should materially reduce the investment cost per unit of capacity.

5. Assuming the question to mean annual savings and to include charges on investment, then: (a) Select location of plant and capacities of units and co-ordinate with existing plants on interconnected systems so as to afford highest justifiable capacity factor to operation of proposed plant. (b) Install only such fuel-saving features as can be amply justified on conservative estimates of future annual capacity factors and future costs of fuel delivered to furnaces. (c) Higher pressures and temperatures at a few standardized values. (d) Greater standardization of parts of equipment, which with a few new or modified parts can be used to further and further reduce first cost and improve performance of complete units.

6. General simplicity.

7. Design to use large units; design to make the station as simple as compatible with a reasonably high efficiency. I think some of the frills that have been added in order to catch some straggling B.t.u. in some of our plants have not been worth the price. Auxiliary drives designed to give higher efficiency under normal operating conditions and at the same time capable of withstanding overloads for periods of two to four hours at considerably reduced efficiencies will, I believe, result in higher over-all plant operating efficiency.

8. Use of large turbines and boilers; running of boilers at high outputs; increase of steam temperature, with resulting elimination of reheat; elimination of reserve and duplicate equipment, material, pipe lines, etc.; simplification of buildings, using lower cost material, and perhaps placing some equipment outdoors (cf Benson boiler installation in Germany).

9. Design for best efficiency at loads normally carried. Eliminate unnecessary auxiliary equipment and spare capacity in such equipment.

10. The accumulation of *accurate* test and performance data of equipment so that designers will be able correctly to choose the equipment and forecast performance, and then standardization of the best equipment, layouts and construction for periods of from five to ten years. New developments should be tried in only a few stations and not universally as at present.

11. I believe that stations should be designed for ease of operation, reduction of maintenance and outage, as one feature offering opportunity for savings. A second opportunity lies in increased steam temperature which will permit increased pressure without reheat. A third opportunity lies, in some geographic locations, in reducing capital cost by simplification of architectural and mechanical design.

12. Any given company can make more money for itself in the immediate future by conservative design and construction, using what might be termed the best of present-day practice, with which both operators and manufacturers have had a certain amount of familiarity, resulting in a station which will operate from the beginning almost as designed. On the other hand, some one has to do the pioneering work, which in general does and has resulted in considerable grief for the first few years, during which time the new type of equipment contributes very little, if any, increase in the efficiency of the system.

13. At present the adoption of the 1,200-lb., 300-lb. steam cycle offers the greatest positive saving. Low temperature carbonization of coal in conjunction with power generation is a possible saving for the near future.

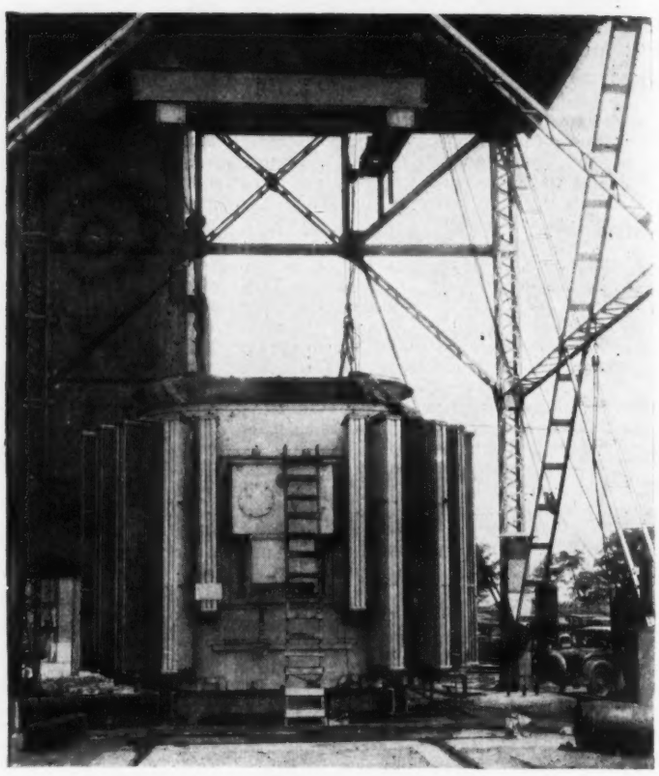
14. It is my opinion that the greatest opportunity for saving in the design of future power stations will not be confined to any particular feature, but that economies and savings will be secured in the further development of prime movers and auxiliary equipment, in further recovery of heat from main units and in developments in boilers and boiler auxiliaries.

15. I believe the designs tending toward the elimination of station buildings and placing more and more equipment outdoors will be the greatest single factor in reducing steam power plant costs.

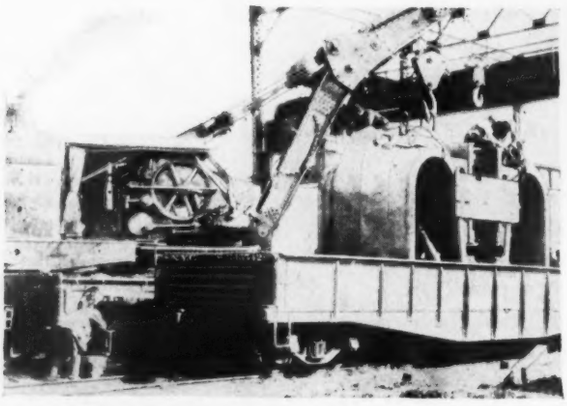
16. I believe the greatest opportunities for savings in design and cost of steam power stations are by using as few and as large units as can be done safely, to decrease the number of spare pieces of equipment so far as it is reasonable to do so, to avoid unnecessary complication and expense for the sake of fancied greater safeguarding of continuity of operation, to pay particular attention to the design of the building, and to spend only such money for increased efficiency as is warranted by the expected load conditions throughout the life of the plant.

17. The simplest answer I can give is that the greatest opportunity for savings lies in the direction of simplification of design. I think it is high time that most of us forgot a lot of preconceived ideas with respect to the ways in which stations are being designed and forgot also the cult of thermal efficiency worship and then sat ourselves down to design the simplest sort of station. I can give you innumerable examples, but a few should suffice. For instance, why do we need overhead coal bunkers? As far as I can see we

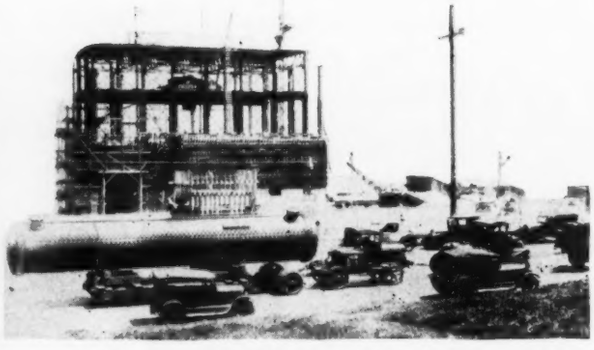
Heavy Construction Problems *Demand Special Equipment*



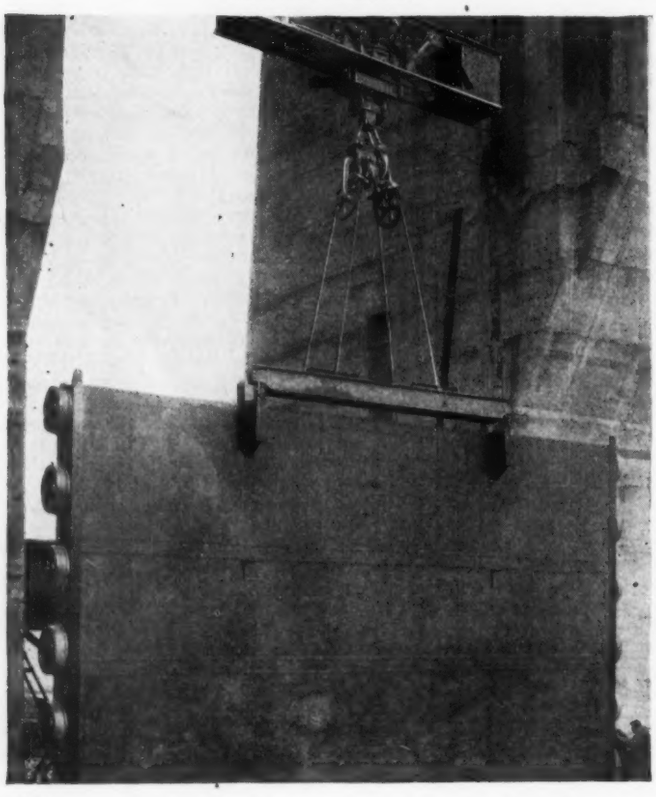
Core and Windings of 25,000-Kva. Transformer Are Readily Handled in Dismantling Tower by Providing Electric Hoist with Box Steel Truss and Hangers for Quadrilateral Attachment of Load at Edgar Station of Boston Edison Company



Steam Crane Unloading Lower Half of Turbine Exhaust, Weight 41 Tons, for Great Western Power Company



Three Trucks Haul 75-Ton Steam Drum for 2,250-Hp. Boiler on Trailer



Lowering Service Gate Into Position by Use of Special Box Truss on Electric Crane in Large Hydro-Electric Job

Photos courtesy of Stone & Webster Engineering Corporation.

use them merely because we started that way a long time ago. As another example, why do we install highly complicated and costly variable speed equipment in cases where two speeds or, at the most, four speeds would give the more economical solution with thermal results which could not be distinguished from those obtained with the type of equipment now commonly used.

As a further example, why do we continue to use piping and other systems which were developed in the days when all apparatus and equipment was so unreliable that we had to have what one might describe as a universal system of spares. I expect to see the day when a boiler or group of boilers will be expected to operate without shutdown for the same period as is now expected in the case of the turbines and I expect to see a boiler or boilers connected by welded construction to the turbines with which they are intended to serve, without by-passes, cross-overs, duplicate lines and other trimmings which were inherited from our grandfathers.

Incidentally and as another example, I do not believe that one out of ten designing engineers purchases condensers on anything more than hunch or the blind following of precedent. Analysis generally shows that much larger condensers are purchased than can be economically justified by the load factor and fuel cost.

18. This question has been answered in questions 1, 7 and 9.

Comments and Conclusions

These answers cover the question well and indicate some outstanding points of attack. The use of large units, high ratings, high temperature, unit systems, outdoor installations, simple layouts, etc., are all embryo elements of good present design and favored present developments. It is an engineering job that will take patience and skill to work out, but it will come. It is merely the task of each design group on each new station to build the station it can build if it knows its work.

It may well be said that the cost of a given station depends on: (1) Intelligent design; (2) intelligent purchasing; (3) skillful equipment manufacture; (4) an experienced and efficient plant construction organization.

Question No. 11

Is it generally advisable, from a cost standpoint, to use the fewest number, highest voltage and largest rating units that it is possible to buy for installation in stations on large power systems?

1. Within reason, depending on the size of the system.

2. Yes.

3. Yes.

4. Not necessarily.

5. Yes, provided such units do not exceed, say, 25 per cent of the maximum load on the system.

6. As a general rule it is advisable.

7. In general, I think this is true, keeping in mind, however, that in any system operation the size of the units must be so proportioned that the system will be able to lose its largest generating unit at any time without seriously interfering with the system operation. This means that the system voltage must not drop more than 10 per cent or the frequency more than 5 per cent. in case the largest unit goes out of service.

8. Yes, as to largest units, but not necessarily as to highest voltage.

9. Having determined the number of spare units required for system continuity the size should be selected which will give the capacity required at the lowest cost. Size of unit depends on size of system.

10. Yes, but the largest unit should not be greater than 10 to 15 per cent of the total installed capacity.

11. I believe the most economical arrangement of units in a large station would call for a size considerably less than the maximum and that units should be duplicated in these sizes for the sake of reduced capital cost and improved operating and maintenance conditions.

12. It is nearly always advisable to use the fewest number, highest voltage and largest rating units that it is possible to buy. These must all be judged by the requirements of the system in relation to its present size and the expected rate of growth.

13. From a cost standpoint, yes.

14. The size of units chosen for any one station must necessarily be based upon the available spare power required in event of failure of a unit. In general, it is my opinion that the size of the single unit should not exceed 20 per cent of the ultimate capacity of the plant, except in cases where the new station is a comparatively small integral part of a large system.

15. I do not believe it is in general advisable to use the fewest number and largest units that it is possible to buy in a new station connected with a large system. In many cases these extremely large units practically consist of an assemblage of smaller units, and very often the over-all operating system thermal efficiency, due to the necessity of carrying hot standby for the larger capacity, is less than if smaller individual units were used. The difference in economy between 100,000- and 200,000-kw. units is very small, but the necessity of carrying 200,000-kw. hot standby, as against 100,000-kw. hot standby, is quite appreciable. With the large unit consisting of an assemblage of smaller units the over-all investment cost per kilowatt installed is not much different for a single 200,000-kw. unit than it would be for two 100,000-kw. units.

16. The larger the units and the fewer the number of both turbines and boilers the less will be the cost per unit of the station. For a turbine, I mean by unit one with a single shaft and one main generator. When one goes to a cross-compound double or triple arrangement he may lose some of the advantages of large size. In the case of pressures above 1,000 lb., however, the cross-compounding becomes almost essential on account of present high-pressure turbine designs being for 3,600 r.p.m.

17. If by "cost standpoint" you refer only to investment, the answer is "yes." If, on the other hand, you refer to cost of power, the answer is not affirmative. Number, rating and size must fit the system in order to obtain minimum power cost.

18. This question again is put in a way that it is almost impossible to answer as it stands. In the first place, except where you take off distribution from the bus that you generate, voltage ought to be determined primarily by the size of the unit and the method of switching adopted. It is obvious, for example, that a voltage that might be objectionable for a 100,000-kva. turbine, where low-tension switching is employed, might be entirely all right where the switching is all done on the high-tension side. Now as regards the rating and the number of units used on a system, these should be a function of the system load. This was discussed in Question 6.

Comments and Conclusions

The large units are favored by the majority. Many years ago Ferranti and Crompton said no station should have less than two units nor more than five, and this is a pretty good economic rule to apply today. System conditions and availability factors govern very largely. It is advisable to fix generator availability factors on a given system from past records and then determine marginal reserve needed as well as the effect of the loss of the largest system unit. These facts govern largely in making decisions on units after local conditions and types of systems are studied. There is little doubt that the large unit is proving most economical in many instances.

Question No. 12

Do you believe there is a practical and economic possibility of using the Benson, the Loeffler or other semi-experimental apparatus in power stations of large size?

1. I do not believe any semi-experimental equipment is desirable in a large plant.

2. Not yet.

3. Yes.

4. Yes.

5. I have not sufficient definite information to answer.

6. Not at present.

7. Anybody's guess is as good as anybody else's on this.

8. No, although certain other equipment now deemed experimental may well be used in future large stations.

9. Not now.

10. There is not enough available experience or information to answer this at present.

11. It never has been wise to say that some new proposition would not work, and I therefore hesitate to prophesy an answer to your question. These boilers do not seem sensible at the present time, but may be developed.

12. Yes, but not in the near future.

13. There is a possibility, but not a probability, in the near future.

14. I am of the opinion that development of boilers for very high steam pressures and temperatures will not be along the lines of our present moderate pressure boilers, but will be somewhat radical, perhaps along the lines of the Benson and Loeffler experiments.

15. No.

16. I do not believe that there is much possibility of using the Benson boiler in a large power station in this country. There may be a chance of the Loeffler boiler being used, but I believe it is rather remote.

17. I believe that equipment of the type listed in your question and other equipment which has not been so well advertised possess practical and economical possibilities which we shall have to consider in due course.

Comments and Conclusions

The general opinion is that the Benson, Loeffler and other semi-experimental boilers have not yet proved themselves for American utility power stations. They are on the way and reports are encouraging, but it appears now that engineers on this side will let Europe install and use these equipments and prove or disprove their practicability for large power production. At present they must be further developed and increased in capacity, but they do promise important savings.

Question No. 13

Do you believe the large systems will operate most economically by using their newest station primarily as a base-load station as compared to utilizing each station as near as possible to its most economical load point?

1. This is the basis upon which we operate at the present time, so that, in case of the system opening up, there will be a minimum interruption to service.

2. Depends on line arrangement and load distribution. The service must be protected before you consider economy.

3. The composite of thermal efficiency, fuel cost delivered and line losses to territory to be served governs the logic of station loading.

4. Depends entirely on the design of the stations considered.

5. In most cases, yes, but it depends on the relative economy of the various plants and on fixed charges and energy losses for transmission.

6. The stations should be operated as a unit by a scientific combination of their loadings. Neither of the specified methods alone will accomplish the result.

7. In general, I believe the most economical operation is obtained by using the newest station as the base-load plant. This, of course, varies, depending upon how much better the newest station is than the other available stations.

8. The newest station will usually operate at the highest load factor.

9. Draw increment cost curves for all stations and distribute load so as to get lowest system cost.

10. This question requires a complete analysis of the limiting operating conditions for continuity of service. When these have been set up, then the only correct way to divide the load, tie feeders being available, is by the "incremental method," either B.t.u. or, if available, incremental costs. We have proved that it is often far more economical to so divide load that none of the stations operates at its best heat rate, but so that the total cost is a minimum.

11. In complicated systems I feel that station operation will be dictated by location and transmission problems as well as by the relative efficiency. Where transmission permits, the newer stations should, of course, be used on the base load.

12. No such general answer to this question is possible. Each system must lay out the operating characteristics of each individual plant and then combine them so as to result in the minimum cost. The answer will depend a great deal upon the relative economy of the different stations, partly as determined by the most efficient units in them.

13. Ordinarily, yes.

14. In general, the newest station will become the base-load station, but the extent of so utilizing the new station must, in each case, be dependent upon the characteristics of the old station and its point of economical operation as compared with the increased economy of the new station.

15. Yes, unless the increment difference in operating cost between the newest station and the next best station is quite small.

16. I do not think this can be answered for all cases by a single statement. The relative sizes, efficiencies and locations of the stations, the extent of the system and the character of the load all have a bearing on this subject.

17. This is a question which could be discussed for hours. In general, if the newest station can be used as a base-load station without involving great investment for transmission and distribution purposes and without unloading the older stations to too great a degree, the carrying of base load on the newest station may be expected to give the more economical results. My observations lead me to believe that the limitations noted are not observed by many of the systems which have adopted base-load operation for the newest station. Putting the matter differently, I think there are many more cases than commonly realized in which it is more economical to operate all or nearly all of the old stations at their best points.

18. On a growing system, this question answers itself. Assuming that the new station is the most economical station, you operate the newest station for all it is worth as you put it on the line. This may be cutting back some of the older stations for a while. Within six months, however, you will find that the older stations, those which can still hold their own fairly well on an economy basis, are carrying as much load as they carried before the new station came on the line. On a system that is fairly more or less static, it is difficult to answer the question. A study of the relative economies involved in the two systems of operation can be made to determine what is the right way of operating.

Comments and Conclusions

The answers vary widely, of course, because of many modifying factors. The decision is governed by service standards and minimum total power cost to the system. No generalization is safe.

Question No. 14

Do you believe a greater use of automatic control to reduce labor charges and improve reliability can be had economically?

1. In large modern boilers producing from 500,000 to 800,000 lb. of steam per hour the value of the coal burned per day is so much more than the wages that I believe the number of employees is fixed by safety rules. Automatic equipment will undoubtedly be installed on these boilers. It will probably maintain better or more uniform operating conditions and in that way increase efficiency and decrease maintenance expense.

2. The tendency is toward automatic control.

3. Much of the automatic control available and used today barely balances with its improved efficiency and saving in labor charges the carrying charges on such equipment, except in localities where fuel costs are relatively high.

4. To a limited extent.

5. Yes, in relatively few cases.

6. Automatic control is now in the midst of development period. Considerable failure has been due to neglect of fundamental questions of safety and proper correlation with other elements of operation. There is no doubt, however, that considerable improvement will be shown within the next few years with automatic control, which makes such control of more value in reducing labor charges.

7. I think that the labor costs are already cut down to about as far as they can be reduced and not jeopardize reliability. I am strongly inclined to feel that any automatic control system which we install must be so designed that the automatic features can be thrown out of commission and the plant put on hand operation at any time. Furthermore, we must at all times have

enough personnel in the plant to operate it satisfactorily and reliably when cut over to hand operation.

8. Yes, but I believe this should be gradual, in order to avoid complications not ultimately warranted.

9. Most new stations are using automatic control to the economic limit now. Some stations go beyond the economic limit.

10. No. In some cases too much automatic equipment is already in use, costing more for supervision and carrying charges than the savings produced.

11. I do not believe there is much opportunity for reducing labor charges and improving reliability by the use of automatic control. Automatic control does not eliminate the necessity for a certain number of men for emergency purposes and usually this number is sufficient for normal operation.

12. I believe that the further amount of automatic control which can be economically installed in the power station is diminishing.

13. To some extent, but the fixed charges and maintenance on the additional equipment cut down the net saving materially.

14. It is my opinion that the extension of automatic control, within the limits of reliability, will produce economies, though not necessarily in reduction of labor costs, but rather through the elimination of waste and the production of more economical operation. I do not believe that the average station has reached the limit of automatic control as regards reliability.

15. No.

16. I believe that the use of automatic control can be and is being overdone. We have gone to complicated and very expensive equipment to gain a completely automatic system of control, where in many cases a less elaborate and more reliable system with partial automatic control would have sufficed. The subject should be carefully considered for each installation.

17. The answer is unquestionably "yes."

18. In general, yes.

Comments and Conclusions

A very general opinion exists that automatic control is at a peak, if not overdone. It is justified in a power station only as it increases continuity of operation and reduces costs. If emergency or safe operating conditions dictate the labor charge, then the automatic equipment loses one of its greatest balance sheet assets. There is little doubt that the opinions expressed indicate the need for a thorough study of automatic equipment in power station applications.

Question No. 15

Do you believe the general trend is toward the mammoth station or to a decentralized or multiple station installation for serving large areas?

1. If I had to furnish power to a large system spread over a large territory I would interconnect the territory with the highest tension transmission line justified and proceed to develop several stations which would be started with one, or at most two, of the largest units which I felt we were justified in installing in that territory. Additional installations would then be made at these plants in rotation, the size of the installations being dependent upon the present prospective load in the territory and the amount of power that can be taken away by the interconnection.

2. In densely loaded areas, yes.

3. A multiple station installation for serving large areas is favored, assuming adequate condenser circulating water is available and there is not too much differential in delivered fuel cost.

4. Depends on water conditions and location of load.

5. The latter.

6. With the improvement in the facilities for transmission at high voltages the trend is toward the mammoth station.

7. See answer to Question No. 5.

8. The general trend is toward the large station.

9. No general answer can be given. Each situation must be considered on its merits.

10. Decentralization is desirable as compared to a mammoth station.

11. I believe the trend is toward multiple station installation; the size to be determined by the density of the load and the transmission conditions.

12. I believe the trend is toward multiple station installation, partly on account of the difficulties of distributing too much power from one point, which would require continual reinforcements of transmission all the way back to the power house.

13. I believe the capacity under one roof will not be much greater than at present.

14. I do not believe that future stations will be built of a size to take care of very much greater territory than is at present covered by the larger stations, but, in order to take care of the power development of the same territory, the station of the future will become what would now be considered a mammoth station.

15. I believe the general tendency is toward the building of mammoth stations due to the general American desire to possess, at least for a short time, the largest station in the world, and I think in many cases this has been done without regard to the economic relationship between generating station capacity cost and transmission cost. I feel, however, that, due to the increasing pressure from the executives of the business to reduce investment costs, there is a decided possibility that the next few years may see a trend toward smaller generating stations supplying local loads. Of course, these stations will be mammoth stations as compared to our ideas of station capacities of some ten years ago, namely, between 100,000 and 200,000 kw. capacity.

16. For serving large areas I do not think we shall see only one so-called mammoth station. Most large power systems are formed by interconnecting centers which have already reasonably large stations. Economic factors of transmission and reliability of service will usually require that power supply for a large system be supplied from more than one source.

17. I believe the answer to this question is determined more by the character of the area served than by any other consideration. In general, it will be found that the multiple station installation works out more economically when more of the transmission must be underground and when condensing water and fuel supply permit. Where a less dense area is to be served and where transmission may be largely overhead I think the tendency toward construction of a few large stations located at strategic points with respect to power distribution and water and fuel supply will, in general, prove the better solution. You will note that density and size of area served, as well as many other factors, must be considered. Possibly the better answer would be to say that economy in station investment and in station operation lies, in general, with the large stations. This, however, may or may not be true in specific cases because of such considerations as those indicated above.

18. This question again is very hard to answer. The general trend is certainly toward a larger station, and it is a trend that has been continuing for many years. It does not look, however, as if there is a trend toward putting all the generating eggs on any system in one basket.

Comments and Conclusions

The replies indicate what must be considered and the difficulty of making a definite answer. But with service standards on the increase and with transmission hazards *in statu quo* and exposures to disturbances multiplying, in general it is encouraging to note that the economic answer is the service answer. A given property will give better service with several good-sized power stations than with a single mammoth station, and this will make for minimum system power costs. All this takes for granted, however, certain load densities and suitable scattered sites.

Question No. 16

Do you believe money spent for architectural effect and for ample operating space is money well spent on power stations?

1. I think it pays to give the operating organization as favorable working conditions as practicable. In some cases space costs money, such as in New York City, where land is high, or in condenser pits on rivers which have big flood variations. However, where land is cheap and there is only a slight variation in water level and foundation conditions are favorable ample space can be provided around equipment at a very small expense. I think those stations having a single line of boilers give ideal working conditions.

2. The latter particularly, yes.

3. Yes.

4. A large steel plant may have a very

pleasing architectural effect, but the same features which made the steel plant pleasing from an architectural effect would not apply to an art gallery.

5. Yes, within reasonable limits.

6. Money spent for architectural effect is sometimes necessary to conform with the requirements of the neighborhood. Money spent architecturally on the inside of the station in keeping with the business for which the station is designed is money well spent. If the station is built so that it can be kept clean and attractive it will have a good effect on the efficiency of labor.

7. I believe in spending the necessary amount of money to get sufficient operating space so that machines can be taken down and put together without excessive moving of the parts. The architectural effect varies in different situations. In general, I do not believe in spending money trying to make a power station look like something that it isn't. We are gradually developing a type of architecture particularly adapted to power stations which is inexpensive and gives a good appearance.

8. Yes, providing the architectural effect and operating space are obtained at relatively slight increase in expenditure.

9. Architecture I know nothing about. Ample space is a good investment; anything more is waste.

10. Money spent for *simple* architectural effects is well spent, but not for ornamentation. Money spent for *ample* operating space is decidedly well spent.

11. Money spent for true architectural design, which consists of some simplicity and proper line and mass, is very much worth while. The very expensive architectural styles used in many instances, however, are unwarranted. Ample operating space is a necessity, but the definition of the word "ample" is very much debatable.

12. Within limits, yes. The architecture for a station may well fit with the characteristics of the surroundings and probable development of those surroundings. Good architecture costs no more than poor architecture and I believe has an advertising value to the company as to the character of its properties as well as the effect upon the personnel operating the plant as to the character of their surroundings. This applies also to the question of ample operating space. The question as to what constitutes ample operating space is somewhat tied up with the type of plant which is being built. That is to say, if it were a steam plant operating as a reserve on a hydro system and actually in operation relatively a few hours in the year, a certain amount of restricted operating space is not objectionable. On the other hand, with a plant which is to be maintained in full operation at full capacity as many of the hours of the year as possible, more room is decidedly advantageous.

13. For ample operating space, yes; for architectural effect, this depends on plant location.

14. Money spent in securing ample operating space may be classed as an essential requirement for proper maintenance and operation, but warrant for expenditures for architectural effect may be limited by the location of the station.

15. Architectural effects, if not too elaborate, and ample operating space can be obtained at a rather small additional cost. These factors both have an effect in improving the spirit of the personnel which will tend toward improving operating efficiency. While it is rather difficult to equate the value in dollars and cents, it is almost generally the case that the housekeeping in a station of pleasing design is better than it is in one of poor design, and wherever good housekeeping is found usually high-grade operating results can be expected.

16. There is a growing tendency, both in industrial and public utility plants, to spend money for architectural effect. I believe a certain amount of this is well warranted in that it improves the tone of the locality and has an effect on the men employed. It gives an incentive to greater cleanliness, better operation and gives one a pride in his work and surroundings. It can usually be obtained at reasonable cost. I believe that ample space for proper operation can be provided at reasonable cost. I think, however, that power station buildings are too expensive and prodigal of space.

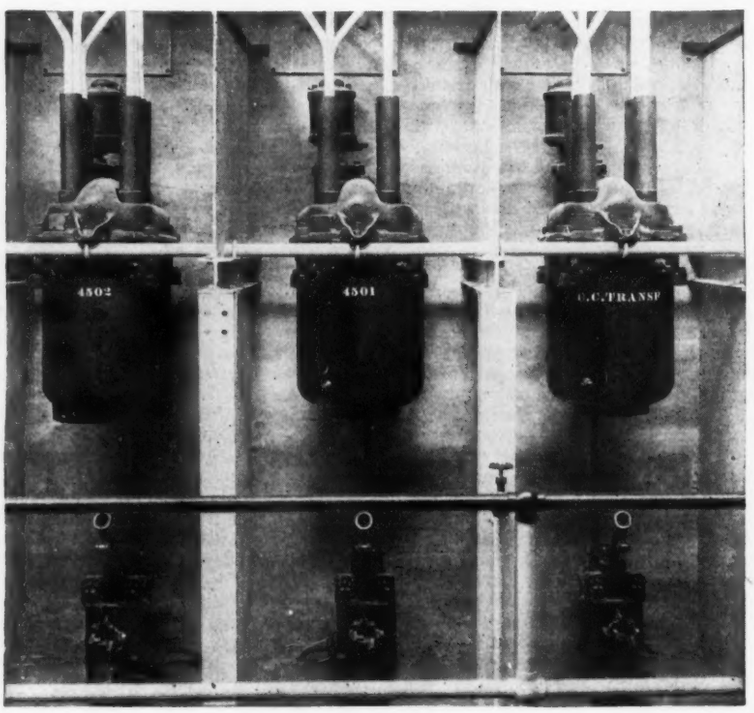
17. Ample operating space always represents money well spent. Architectural effect is in a different category. If the station is located in a place where architectural effect is required to bring it up to or above the character of surrounding structures money spent for that purpose is justifiable. If it is not so located one is justified in spending for architectural purposes only that amount which will give the building the self-respecting aspect required to instill pride in its operating personnel.

18. The thing can be overdone and, in general, we believe it has been overdone. Except in large centers, there is no reason why considerable amounts of money should be spent for architectural effects. By a proper study, good effects can be obtained for very little money.

Comments and Conclusions

Engineers are not prone to comment on architecture, but they insist on the importance of ample operating space. In too many cases convenience and safety for operating staffs have been sacrificed to gold plate some gargoyles on power stations. But there has gradually emerged an American design of power station exterior that is a splendid example of appropriate architecture. It is as truly American as the modern skyscraper architecture and far superior to that found in steam stations abroad.

Steel Barriers for Breaker Cells

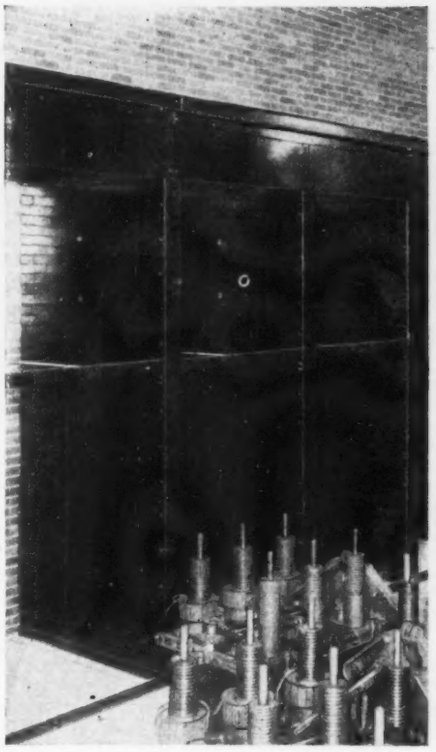


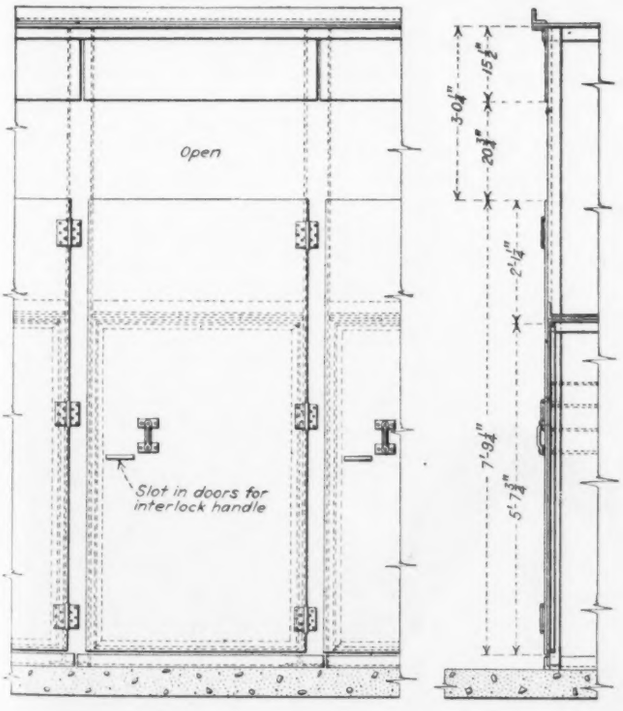
INSTEAD of brick, concrete or composition material for separators between oil circuit breakers, steel partitions were used in this substation. To support the breakers as well as the barriers horizontal and vertical I-beams were molded in the wall and floor concrete respectively as shown, the partition steel being attached thereto with angle irons. Two pipes are supported on the horizontal I-beams and attached thereto with U-bolts for mounting the breakers.

All-Steel Cell with Simple Interlock

AFTER considerable experience with cell structures of many types, the West Penn Power Company has adopted as standard an all-steel cell structure for low-tension distribution circuits, according to G. C. Spray, assistant substation design engineer. This structure is composed of standard channel and angle sections with No. 11 gage plate for partitions, barriers and doors. It is built in two compartments. The lower for the oil circuit breaker, the upper for single-throw, hook-type disconnecting switches and the longitudinal bus.

The door is hinged on loose pin hinges and is interlocked mechanically with the breaker so it cannot be opened with the breaker closed. This interlock consists of a $\frac{5}{8}$-in. diameter rod bent on one end in the shape of a handle; the other end is bent to 90 deg. This rod is supported by angle clips to which stops are provided limiting the travel from open to closed to 90 deg. A bolt is





Rod Operated by Breaker Closure Prevents Opening Cell Door

attached to the operatng pipe of the breaker; closing the breaker moves this bolt and locks the interlock rod. When the breaker is open the rod is free to turn. A rectangular slot is provided in the door, permitting the door to swing open when the handle of the interlock is in the open position. A knife switch is operated by the interlock rod, which is open when the interlock is open, and closed when the interlock is closed. This switch is in series with the control wires from the switchboard and prevents the operation of the breaker from the switchboard while the door is open.

The door is of sufficient height to prevent the pulling of any disconnect switch, but still leaves sufficient open height (20 in.) for visual inspection of bus and switches. Thus a maximum of protection is gained. It is impossible to open a door into an energized cell; it is impossible to break load on disconnecting switches, and impossible for an operator accidentally to close a breaker while it is being repaired or out for repairs.

Considerable economy is obtained in a structure of this type. It can be designed as strong and rugged as conditions warrant. Oil breakers of different sizes can be interchanged without dismantling or altering the structure by providing a few extra holes. Additions can easily be made as it is built in unit formation. Estimating and design for new installations is minimized. Due to existing records and in most cases complete existing drawings, it can be fabricated and erected as economically as any ordinary steel structure, thus requiring no form work or extra skilled labor.

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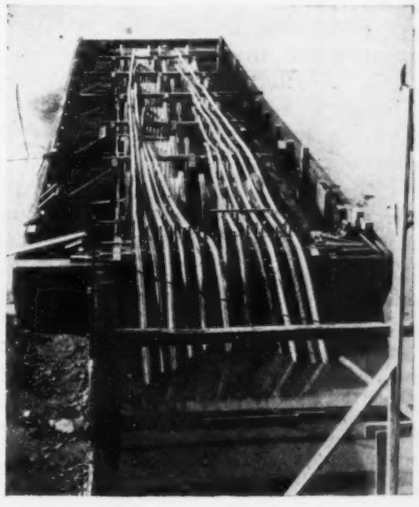
12 Submarine Cables Laid Together

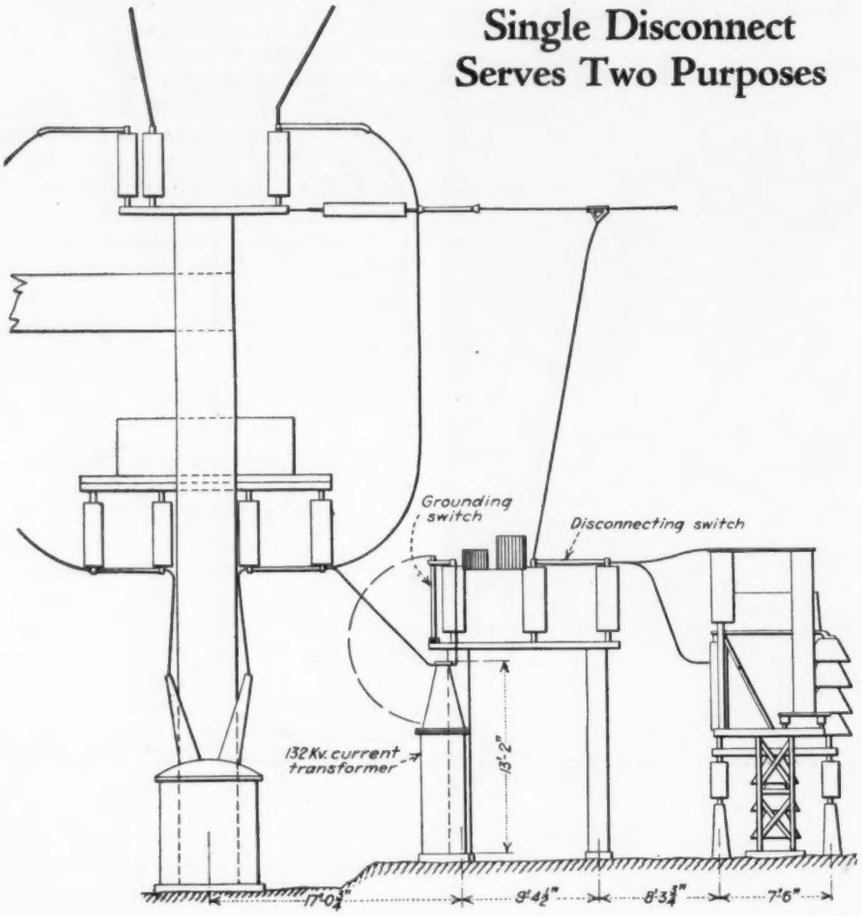
LAST year when it was necessary to increase the cable connections between the Brunot Island generating station of the Duquesne Light Company and the mainland twelve cables were laid at one time by mounting the reels as shown on a barge. It will be observed that the reels are supported in pairs down the length of the barge and that the cables are led over rollers and through separators at one end of the barge. The rollers between and above the reels keep the cables from dragging on the reels beneath. Two



rollers are used at the end of the barge with a series of vertical pipes between them to serve as guides.

Laying the cables in this manner saved time and also assured their placement on the river bed in such a way that any cable can be later extricated without the difficulty that might be incurred if the cables had been laid in installments and overlapped each other.

Single Disconnect Serves Two Purposes



A COMBINATION choke-coil support, arrester disconnect and line grounding disconnect is standard construction in the 132-kv. substations of the West Penn Power Company, according to William C. Bowen, substation design engineer of the company.

When adding a new 132-kv. circuit extension to an existing substation along with a carrier-current installation the question of adding an extra disconnect for the latter was given serious consideration. It was found that one set of gang-operated disconnects, which is the present standard installation, would satisfactorily serve to disconnect both the arrester and the carrier-current condenser. The arresters can always be removed from service if it is necessary to remove the carrier-current condensers, and in case of arrester trouble the carrier current can be out of service long enough to disconnect the arrester and remove the arrester lead from the disconnect. Either piece of equipment can be very quickly disconnected from the disconnect switch.

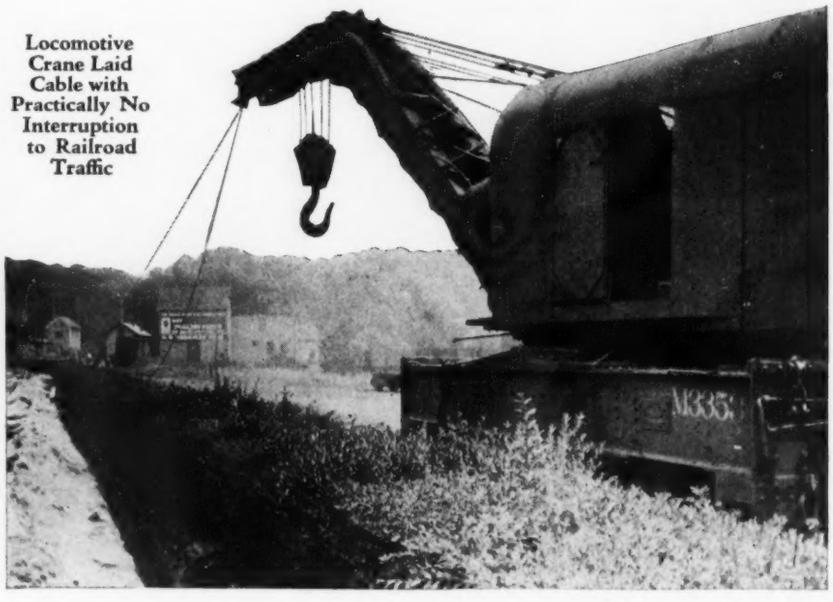
It can be observed from the illustration that the one combination structure supports the line choke coil, the tuned carrier-current choke, the three gang-operated switches and the three gang-operated grounding switches. This scheme has no serious disadvantages and will not handicap operation. A saving in cost was effected by thus eliminating the 132-kv. disconnect switch as well as saving in ground space. It was thus possible to get a compact unit with good clearances.

Wrecking Crane Lays Cable

IN EIGHT weeks 68,000 ft. of 25-kv., lead-covered, three-phase, armored and jute wrapped 250,000-circ.mil cable was pulled from reels and laid in earth trench along the right-of-way of the Boston & Maine Railroad between Beverly and Gloucester, Mass., by the engineering department of Charles H. Tenney & Company, Boston, during the past summer.

About 1,000 ft. of submarine crossings was also pulled on this job. The major equipment employed was a wrecking train hired from the railroad company and consisting of a steam locomotive, wrecking crane car, flat car, caboose and car for transporting reels. On straight runs four reels per day were normally pulled, giving a total lay of from 3,200 to 3,600 ft. The cable reels were removed from the car by the crane, placed in position on a wooden cradle beside the roadbed and pulled by the locomotive or crane through a ¾-in. steel line.

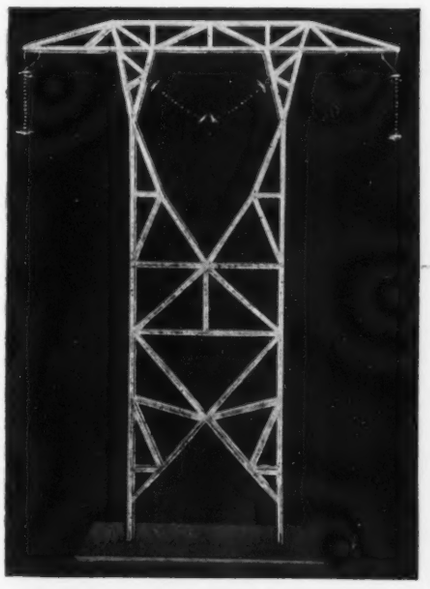
The manufacturers left the armor long enough to permit bending back the wires to form an eye to receive a hook for attaching the pulling line. Ninety-two reels were pulled and the cable was laid from 18 in. deep in earth to 4 ft. depth under tracks.



Locomotive Crane Laid Cable with Practically No Interruption to Railroad Traffic

Bridle Suspension Saves Tower Material

IN PRELIMINARY studies of the towers for the Fifteen-Mile Falls-Massachusetts 220-kv. line of the New England Power Association system it was found that the tower width would have to be 30 ft. unless some method was developed to restrain the center conductor from transverse movement. Such a width would have precluded the use of semi-flexible towers, chiefly on account of the heavy transverse braces which would have been required by the great unsupported length of members carrying little stress. The desired restraint was secured by a construction in the form of a bridle made up of two regular insulator strings drawn together in the shape of a "V" to support a single conductor. The angle of the strings is arranged to prevent a side wind exerting enough force entirely to relieve the opposing string of its vertical load.



Model Tower Showing Bridle Suspension Which Facilitated Compact Design

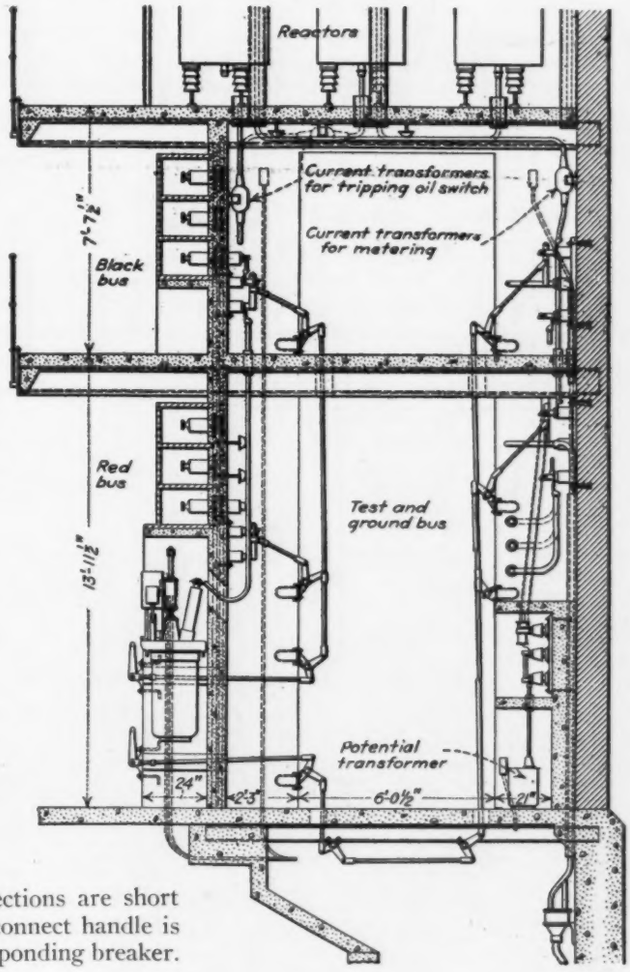
This type of conductor suspension enabled the towers to be made only 19 ft. wide, thus saving 11 ft. in width and making marked economies in material. The excavation cost for tower foundations is about 25 per cent of that required by a square tower. Insulator strings with fifteen disks each are used and the line contains 1,930 standard 55-ft. suspension towers and 420 square towers for special requirements.

A Cheaper Cable-Pulling Job

THE Brooklyn Edison Company uses a 4-in. bell-topped steam hose to lubricate and guide cable in duct pulling. In the case of the four-wire network system a considerable saving in installation cost is effected by having the cable manufacturer reel the three individual lead-covered insulated conductors in 500-ft. lengths on a single reel. This conserves street space and cable helpers. The bare neutral conductor is carried on a separate reel, but all four are pulled into the duct at one time.

Semi-Isolation in Small Space

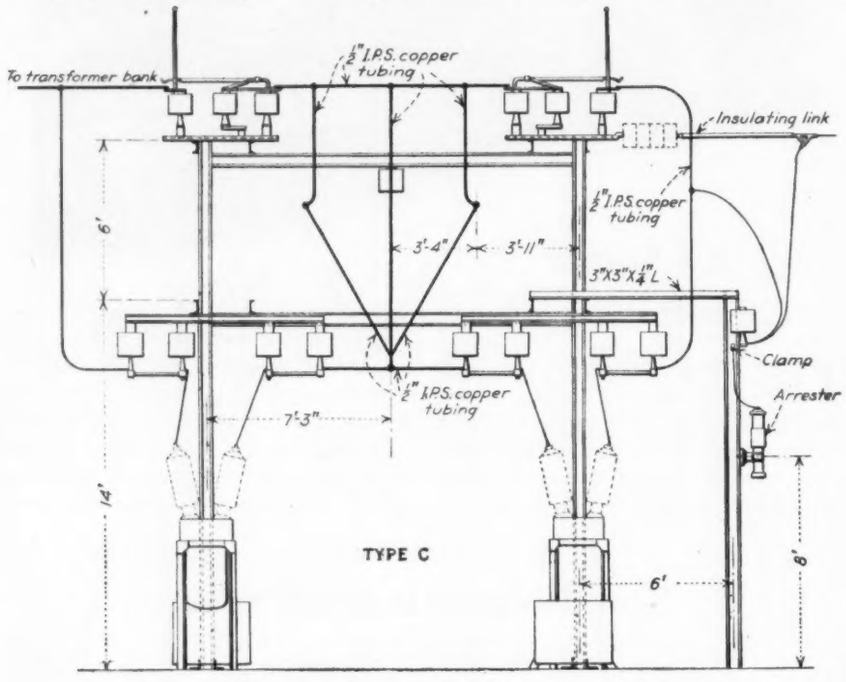
EFFICIENCY of space utilization, effective isolation of the red and black buses, shortness of connecting circuits and ability to operate the disconnect mechanisms while the corresponding oil circuit breaker is in view are features of this construction used by the Consolidated Gas & Electric Company of Baltimore.



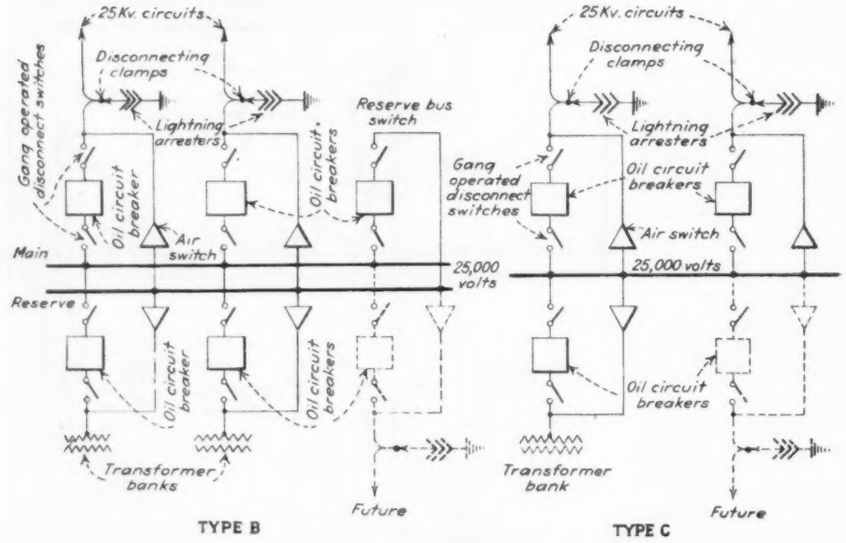
The duplicate buses are separated from each other by a concrete floor which extends far enough so any fire in either bus is kept from the other bus. The buses are also isolated from their respective disconnects and tap circuits by a concrete wall. Still the connections are short and direct. The disconnect handle is adjacent to the corresponding breaker.

25-Kv. Outdoor Substations Standardized

TWO types of outdoor substation structures have been adopted as standard for serving 25-kv. load, says F. G. Boura, assistant substation design engineer West Penn Power Company. One, designated as type B, is designed to accommodate the largest oil circuit breakers used for this voltage and has a reserve bus with double three-pole gang-operated disconnects and gang-operated air switches to allow connecting any line or transformer bank to either bus. The other structure, designated as type C, is for numerous small industrial plants and is more economical in space requirements and capital outlay. Besides, it is designed for smaller breakers.



Type of Structure for Small 25-Kv. Industrial Loads



Circuit Arrangements for Serving 25-Kv. Loads

Type B—This structure is 18 ft. wide, 19 ft. long, and 24 ft. high, is made up of 6-in. channels laced with 2-in. x 2-in. x ¼-in. angles. This structure has been so designed that only nine items of steel are required. Reducing the number of items simplifies sorting the steel, decreases cost of labor for erection, simplifies fabrication and minimizes the cost of the steel. The first bay weighs 9,760 lb. and each additional bay weighs 6,030 lb.

The main and reserve buses require 1½-in. I.P.S. copper tubing. Cross connections from air switch to air switch are 1-in. I.P.S. copper tubing and the other connections are ½-in. I.P.S. copper tubing. The total weight of copper for one bay is 592 lb.; twelve bus tee taps and eighteen 37-kv. pin type insulators are required in this structure.

Type C—This structure is 14 ft. 6 in. wide, 14 ft. long and 20 ft. high with 6-in. "H" beam columns and consists of five items of steel. The first bay weighs 4,985 lb. and each additional bay weighs 3,170 lb. This structure has only one bus, which is 1-in. I.P.S. copper tubing. All cross connections and taps are made of ½-in. I.P.S. copper tubing. The total weight of copper for one bay is 228 lb.; eighteen bus tee taps and twelve 37-kv. pin type insulators are required. Except for the oil circuit breaker being of a smaller type for the type C structure the balance of the equipment is identical with that in type B and therefore is omitted in the comparison.

In both of these designs an attempt has been made to simplify the layout to take care of two 25-kv. circuits per bay or one 25-kv. circuit and a bank of transformers.

Standardization of these substations has effected several advantages, namely:

1. Additions in the future will be simplified. Although it may be after the lapse of several years, the structure will have the appearance of a coherent whole. Thus it allows building the substation as the load comes on.
2. Land requirements and cost estimates are simplified because of duplicating previous work.
3. Engineering and drafting room work is simplified due to previous experience on the same general design.
4. Construction work being standardized is reflected in labor economy and appearance of the finished work.
5. Operating orders are simplified.
6. It allows purchasing of steel and electrical equipment for several substations at one time and on one purchase order, even before the substations are designed for their respective locations.

The experience gained from standardization proves that the maximum simplicity, economy and safety has been secured for the capital invested.

Standard Drawings Cut Costs

IN THEIR efforts to reduce costs many engineers have overlooked the possibility of economies in engineering and design through the use of standard drawings, yet this is a field that offers opportunities for savings, perhaps not as great as in conserving labor and material on the job itself, but none the less worth while.

One Pacific Coast utility has found that by the use of so-called standard or system drawings it is possible to design a substation and utilize as many as 80 per cent of drawings already on file. This company has found that there is no necessity or object in getting out a complete set of new drawings for every substation

built when each station is virtually a duplicate of previous stations of the same type, except perhaps for ground plot layout. This practice does not in any way prevent evolution in substation design, because as new designs are found desirable they immediately become system standards and the drawings are then available for the succeeding station of the same type.

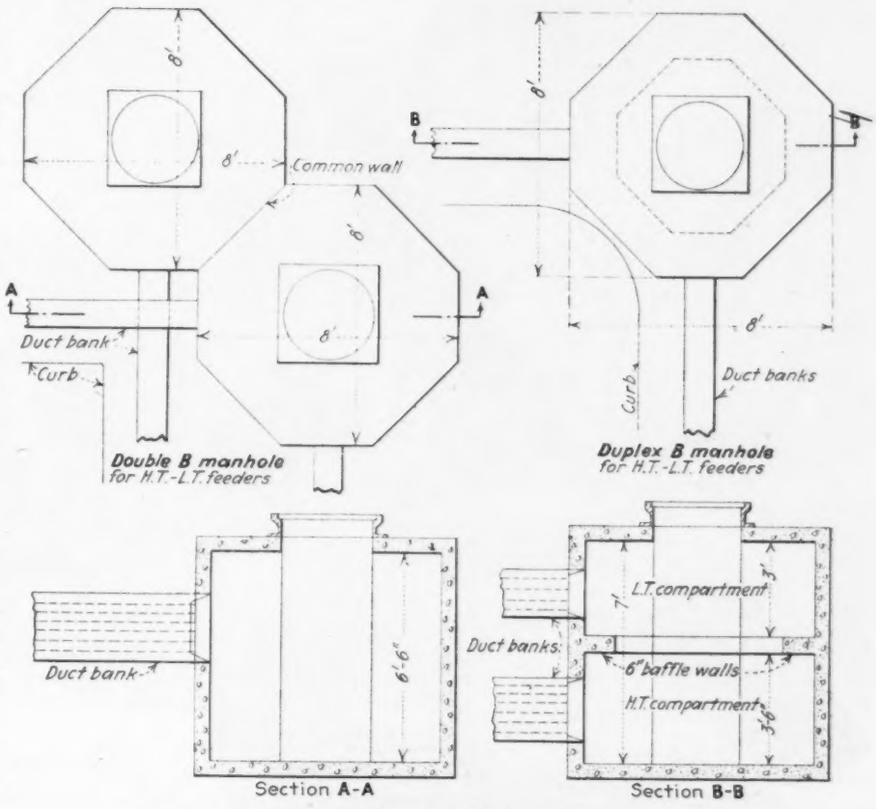
Protecting Shore Ends of Submarine Cable

IN BUILDING a 22-kv. underground line between Beverly and Gloucester, Mass., the engineering department of Charles H. Tenney & Company, Boston, was obliged to provide for cable protection at a submarine crossing beneath the Annisquam River, a swift tidal stream with a rocky shore subjected to severe ice battering in winter. Bids were received for doing this work with tile pipe or a trough with removable cover, but the cost was so high that the field engineering organization met the situation by designing a reinforced concrete conduit about 60 ft. long and 2-ft. x 3-ft. in end section, the upper edges being protected by 4-in. angle-irons. The conduit was doweled into the rocky shore and placed at an angle of about 50 deg. with the horizontal. The

Where the Cable Leaves the Water

cable was anchored into the rock ledge at the top of the run and the cost of the conduit installed was approximately $1,300. Space was provided for a second cable like the first—a 250,000-circ-mil, paper-insulated, lead-covered, armored and jute-wrapped three-conductor section.

Duplex Manholes Effect Plant Economies



Duplex Manhole at Right Replaces Double Manhole at Left

The figure at the left shows two standard type B manholes 8 ft. x 8 ft. x 6 ft. 6 in. constructed as close as possible to the curb at a street intersection. The figure at the right shows a duplex type B manhole 8 ft. x 8 ft. x 7 ft. at the same location.

ELECTRIC subway outlets for Westchester Lighting Company substations are designed to accommodate high-tension feeders (13.2 kv. or over) and commercial (4.0 kv.) and street-lighting (8.0 kv. series) circuits.

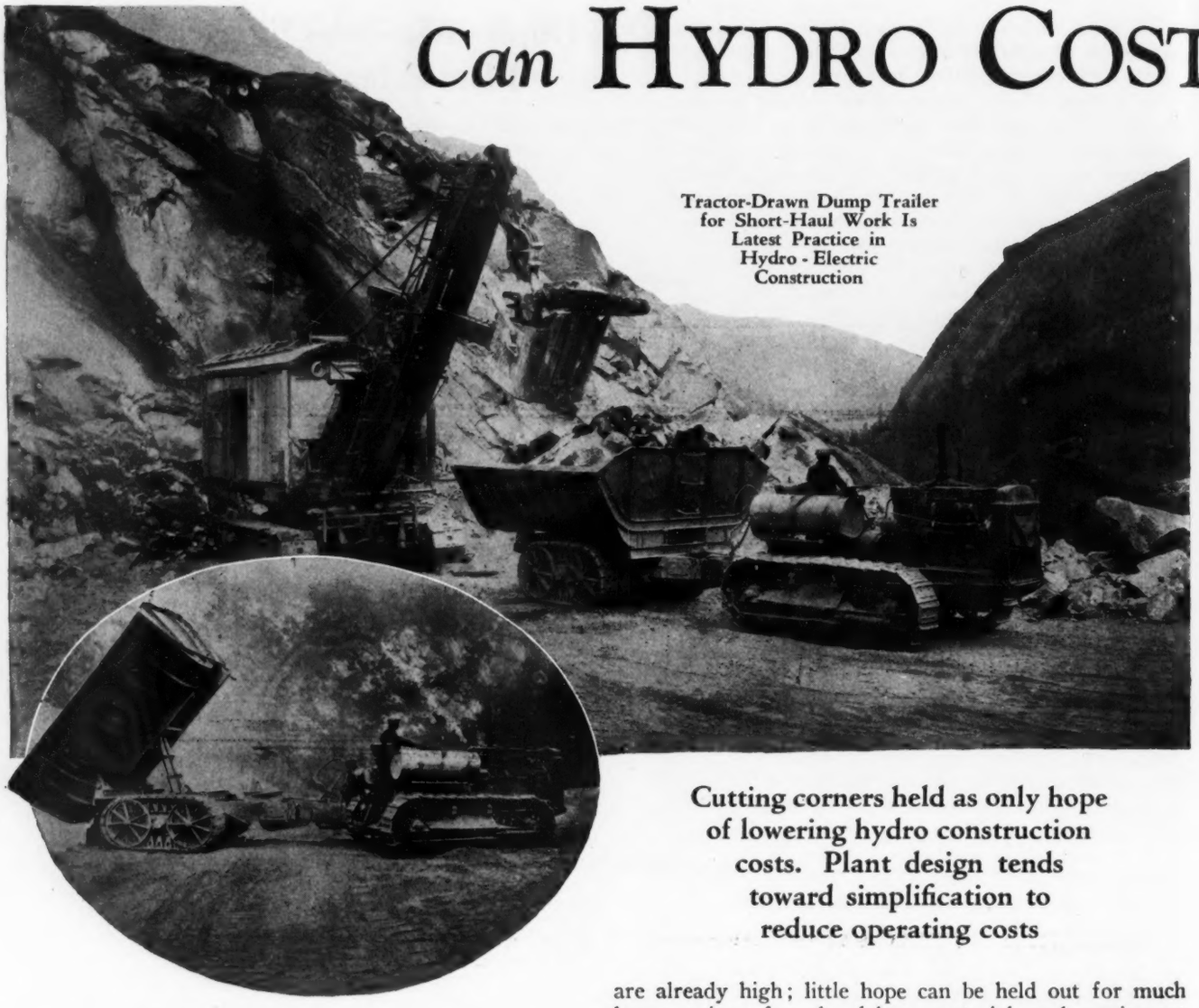
It has been the practice of the Westchester company not to place 45 kv. feeders in the same manholes with 4 kv. or 8 kv. circuits. This has necessitated two separate manholes, one for high-tension feeders and another for commercial and street-lighting circuits. The construction of two separate manholes at a street intersection due to field conditions, such as subsurface structures, rock, quicksand, etc., is often difficult and expensive. In such cases duplex (compartment) manholes have been constructed.

This type of manhole is designed to care for high-tension feeders, commercial and street-lighting circuits. It is accomplished by increasing the headroom of a standard manhole from 6 ft. 6 in. to 7 ft. and constructing a baffle wall 1 ft. wide and 6 in. thick, 3 ft. 6 in. off the floor. This divided the manhole into two compartments, the bottom one for high-tension feeders and the top one for commercial and street-lighting circuits. The baffle wall is designed to prevent any burnouts which may occur in one from injuring the cables in the other compartment. Through the use of one duplex type B manhole it is possible to accomplish the same purpose as two standard type B manholes and effect a saving of approximately 45 per cent. In addition to this there is, of course, the added advantage of time saved in construction and less interference with traffic.

Where a straight duct run is involved two standard type A manholes 5 ft. x 8 ft. x 6 ft. 6 in. were formerly constructed. Here, also, the duplex type A manhole, 5 ft. x 8 ft. x 7 ft., can be used with a similar saving in construction cost.

Obstruction of traffic is also limited by this construction.

Can HYDRO COSTS

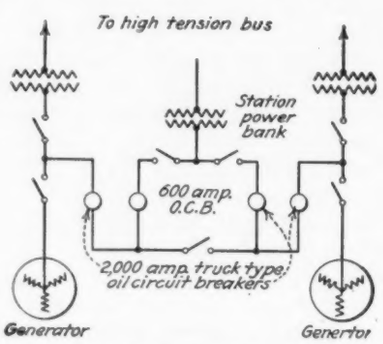


Tractor-Drawn Dump Trailer for Short-Haul Work Is Latest Practice in Hydro-Electric Construction

Cutting corners held as only hope of lowering hydro construction costs. Plant design tends toward simplification to reduce operating costs

ASKED how hydro-electric construction costs can be reduced, one prominent utility engineer said, "Build steam plants." Applied to many sections of the country, even on the Pacific Coast, where a high percentage of all generation is from water power, there is more truth than subtle humor in this statement. Witness the major steam plant construction program of the Southern California Edison Company and the fact that the Pacific Gas & Electric Company, Great Western Power Company, Northwestern Electric Company and Puget Sound Power & Light Company are all making substantial steam plant additions. It is not meant to imply, however, that hydro no longer has a rightful and economic place in the field of central-station power generation. It simply means that with practically stationary hydro costs, in the face of declining steam costs, the balance is temporarily, at least, swinging toward steam.

In considering the possibility of reducing hydro costs the engineer immediately comes face to face with certain facts. Efficiencies of both prime movers and generators are already high; little hope can be held out for much lower prices for the labor, material and equipment entering into a hydro project; larger units and simplified plant layout mean less operating labor per kilowatt of plant capacity; given physical conditions largely determine unit costs, assuming that labor and materials are judicially utilized. Thus, the problem resolves itself into one of cutting corners, so to speak; that is, bringing about a large number of small savings, none of which in itself means so much, but which in the aggregate are well worth while.

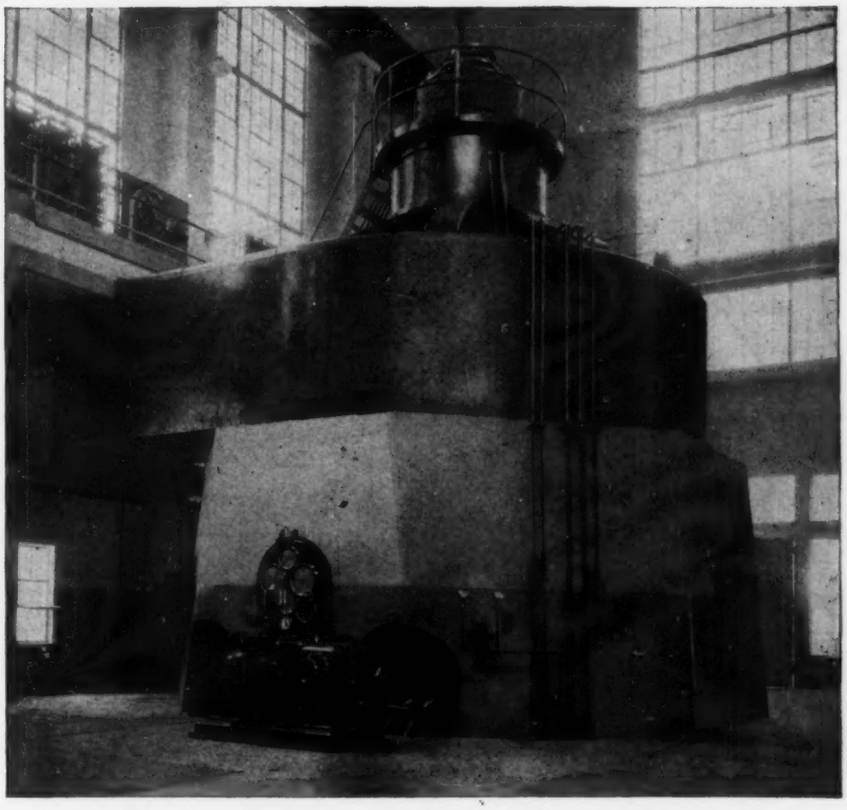


Switching Which Eliminates Low-Tension Bus and Utilizes Cross-Tie Breakers for Synchronizing

It is a problem, not so much that of saving money, as it is one of avoiding wasting large sums. That is to say, the commercial efficiency of a development is the all-important factor. If a development is estimated to cost, say, $3,000,000, and will deliver power at a reasonable price in competition with other power production sources based on an investment of $3,000,000, then if mistakes in engineering judgment and unforeseen difficulties arising on the job raise the actual cost to $4,000,000, the commercial efficiency of that plant is only 75 per cent. Under these conditions no amount of penny pinching in design and choice of equipment

TS Be Reduced?

By Walter Heston
Pacific Coast Editor "Electrical World"



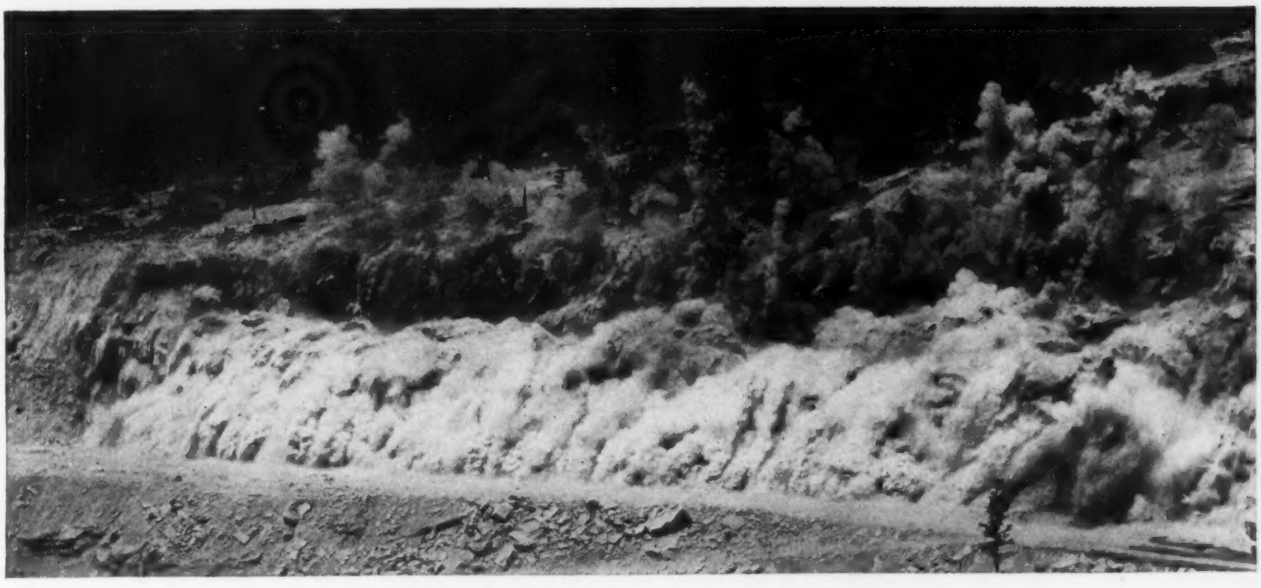
Pedestal Mounting of Generators Saves an Extra Power House Floor

will make that an economical plant. This is a point too often overlooked in undertaking a project and comes about as a result of lack of preliminary study, error in judgment or too much haste. Five per cent spent in preliminary investigation and study may save 25 per cent in the cost of the job.

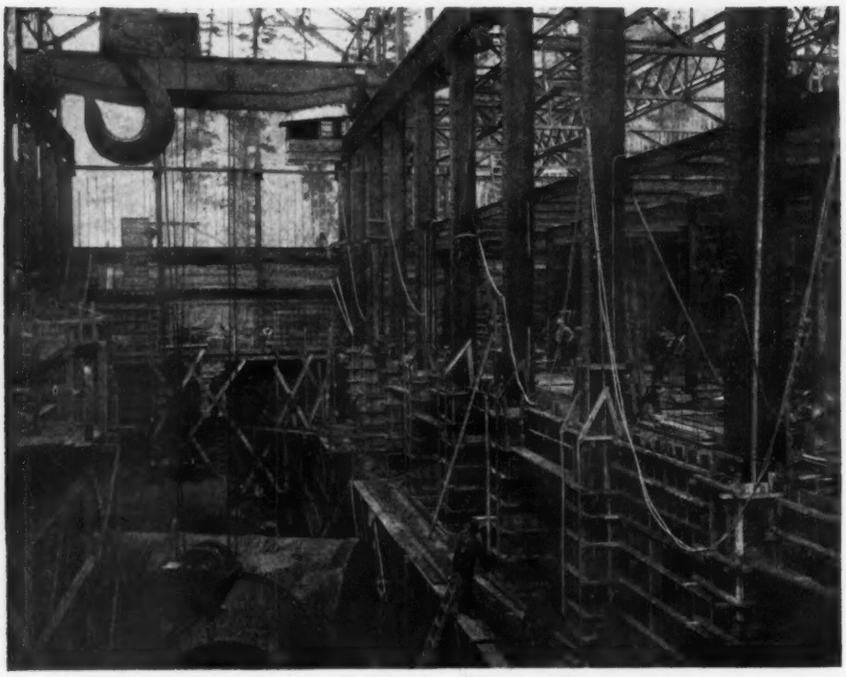
This brings up the question of contracting the engineering and design and the construction versus the utility utilizing its own staff. No hard and fast rule on this point can be laid down, but in general the most economical course to follow depends largely upon whether the company has a sufficiently sustained hydro construction program over a period of years to maintain and keep busy a competent engineering and construction staff. One of the advantages a holding company has in this respect is that a central engineering organization can be maintained at good load factor due to the diversity of construction requirements of several operating properties, although holding company headquarters are often too far removed from the job to obtain maximum benefits from this set-up.

The fact that approximately 50 per cent of the total cost of a hydro-electric project is expended in labor makes it important to watch every detail of the job and properly co-ordinate the work to the end that labor costs and interest during construction do not become excessive. Lack of co-ordination between the various component parts of a job may result where all or part of the work is let out on contract and there are several contractors or sub-contractors. A case in point was a project where there were some seventeen sub-contractors, several of whom were dependent upon another for transportation. When the firm having the tunnel contract finished its work part of the narrow-gage railroad was torn up and the contractor on the diversion works was left with no means of transportation but auto trucks. Due to muddy roads several months' time was lost in completing the job.

In undertaking any development, transportation is the



Tons of Rock for Dam Construction Are Moved in a Single Blast



Equipment Erection and Concrete Work Proceeding Simultaneously to Reduce Construction Time

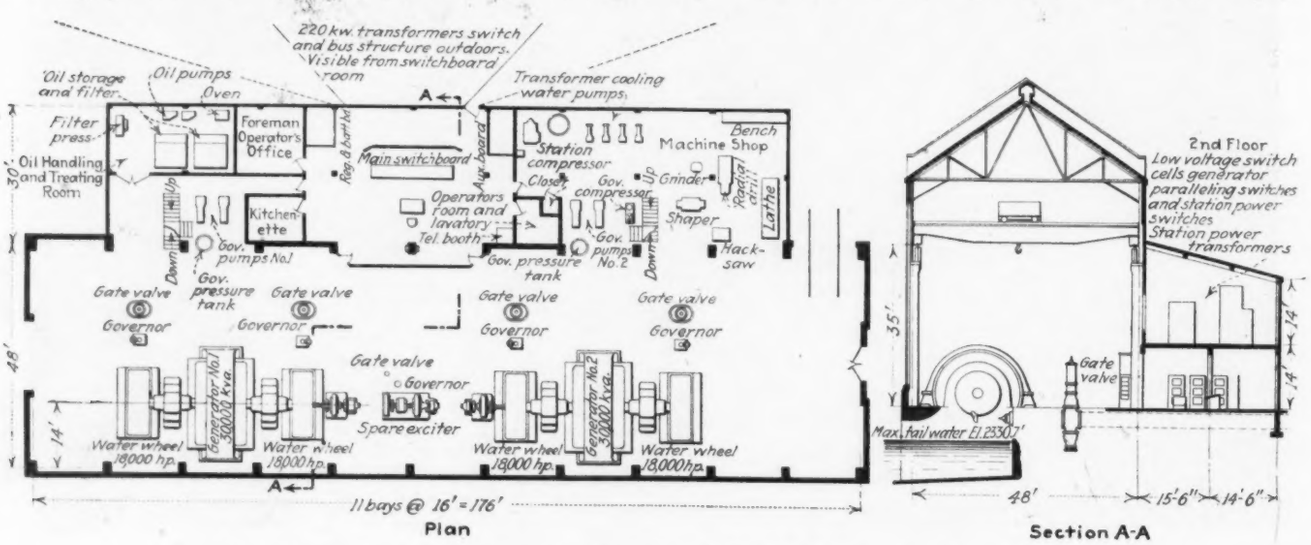
first requisite and often amounts to a fair percentage of the total cost of the job where the site is situated in mountainous country. The choice between a railroad and a trucking road depends largely upon weather conditions and the loads to be transported. In general, railroads have been used, but the auto truck road offers advantages of economy and is coming into greater favor with each job.

Airplanes for reconnaisance and mapping purposes have been used to excellent advantage on many jobs and at a large saving in cost over ground work. This is particularly true in the preliminary stages of a development. Some of the first aerial surveys were made in planes owned by the utility itself, but with many commercial agencies now specializing on reconnaisance and surveys the utility need no longer engage in this activity.

For any given site the hydraulic features of the job are largely determined by physical conditions. There is considerable diversity in practice as to dams, diversion works and intake structures, but as these represent only about 10 per cent of the cost of the job, design is dependent more upon low maintenance and operating expense than upon capital costs. Choice between an open water way, steel flow line or tunnel depends, first, to a large extent, upon the topography of the country and, second, but of great importance, upon maintenance. An open ditch, lined with either timber or concrete, may easily cost so much to maintain and may be so undependable under severe weather conditions that many times the original investment would have been justified in boring a tunnel or using a steel pipe flow line.

Surge chambers vary somewhat in design and their physical character depends upon conditions encountered on a particular job. Little opportunity for saving is offered here. Penstocks, on the other hand, amount to 3.5 per cent of the cost of a job or more, depending upon the head and other conditions, and offer a field for study. It seems illogical in many cases to install several penstocks when there is only one tunnel, flume or pipe line, one surge chamber, one valve, etc. When the ultimate plant is to be built initially one penstock may be used, as was done at the Big Creek No. 2 plant of the Southern California Edison Company for two 56,000-hp., double-overhung impulse units and is being done with the Tiger Creek plant of the Pacific Gas & Electric Company. The Edison plant was a high head development with long penstock line and the penstock cost amounted to approximately 25 per cent of the total job. Utilizing one penstock for both units effected a saving of $400,000 in this case. Use of butterfly valves instead of the balanced plunger type and a simplified type of gate valve have effected savings on several jobs.

The whole tendency in hydro plant design has been toward simplification. Operating rooms so located as to permit a clear view of both indoor and outdoor equip-

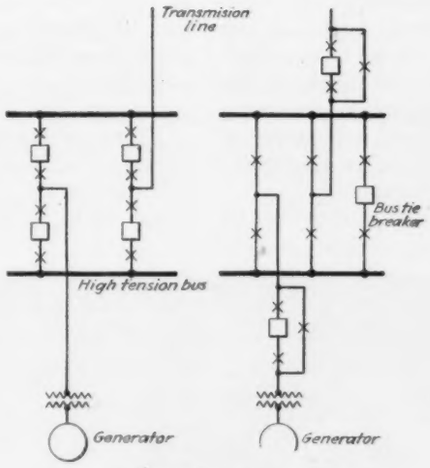


Simplicity and Operating Convenience Are Features of This Hydro-Electric Power House Layout

ment, control concentrated on the switchboard so that a minimum of labor is required for plant operation, automatic and semi-automatic operation, centralizing of auxiliary equipment for operating convenience, elimination of low-tension buses and operating generators and transformers as a unit, improvements in turbine design to facilitate inspection and repairs—these are some of the things that have made for reduced investment, simplicity and lower operating cost.

Larger and more efficient units have brought about lower investment costs per kilowatt of installed capacity and have reduced space requirements. Pilot exciters on generators in place of field rheostats have improved stability, saved in assembly and wiring costs and have greatly improved plant operation. In the past it has been usual practice for the manufacturers of generators and the manufacturers of turbines each to supply an oil pump for bearings. One pump will serve the purpose just as well as two and, moreover, would reduce investment and operating costs. The turbine pump is generally accessible, whereas the generator pump is not, and the former therefore would be the one most logical to serve both purposes.

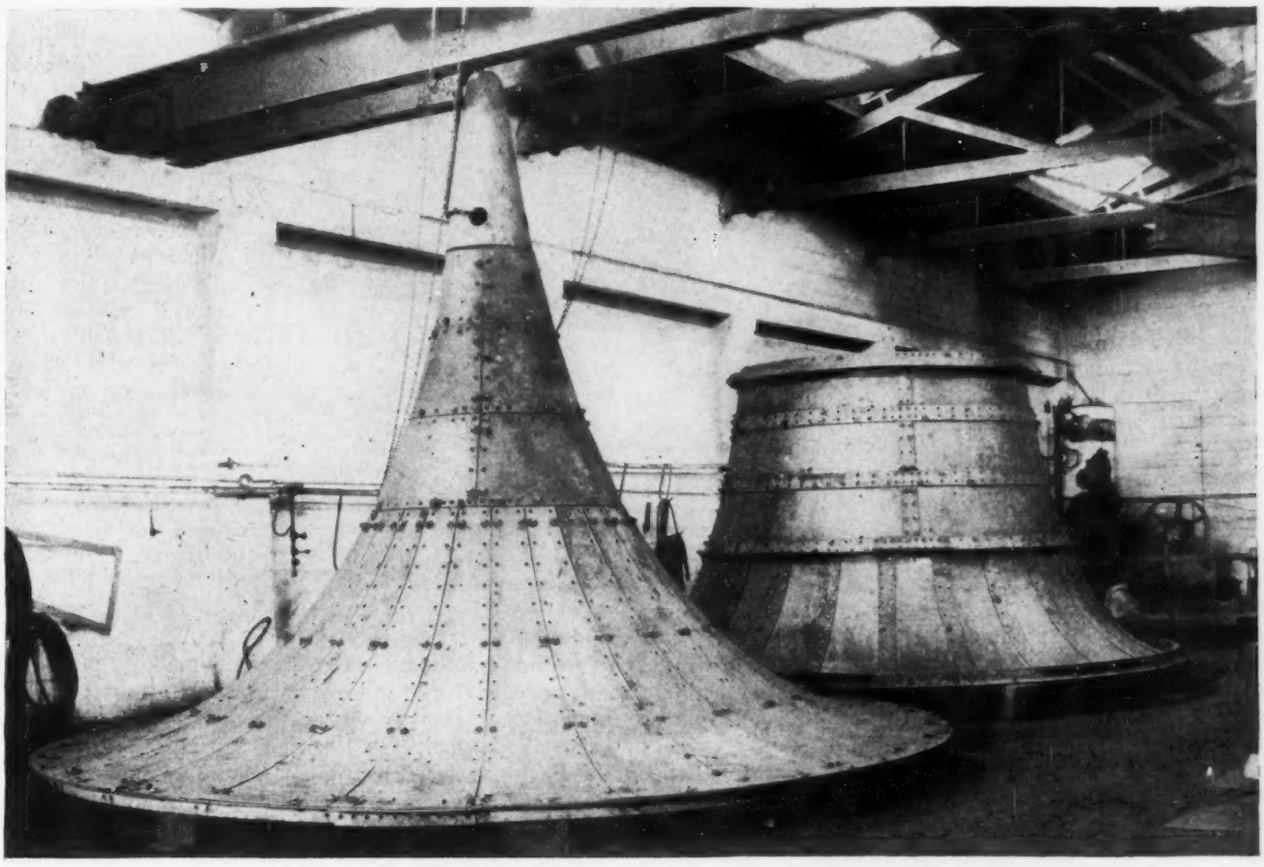
As to electrical layout, the tendency has been toward elimination of the low-tension bus and operating each generator with its transformer bank as a unit and paralleling the station on the high side of the transformers. Such a scheme is being used at the Tiger Creek plant of the Pacific Gas & Electric Company and is diagrammatically shown on page 636. In this scheme synchronizing is done on the generator side of the transformers by means of a low-tension oil circuit breaker because of the time delay in the operation of 220-kv. breakers.



Two High-Tension Bus Arrangements

The procedure in synchronizing is to open the 220-kv. breaker, bring the unit up to speed and synchronize with one of the breakers in the low-voltage cross-tie between generators. Upon completion of synchronizing the 220-kv. breaker is then closed and one of the low-voltage breakers opened, so that each generator operates as a unit with its transformer bank and transmission line. The low-voltage cross-tie breakers are capable of handling full generator current, but passing current through them continuously is avoided by the method of operation above mentioned, thus obviating contact heating and excessive maintenance.

In this scheme it will be noted that one of the two oil circuit breakers used to supply the station power transformer bank is of the same capacity as are the two cross-tie breakers. All breakers are of the truck type and with this arrangement the large breaker on the station transformer bank may readily be substituted for either of the cross-tie breakers during overhauling or inspection.



Steel Draft Tube Liners Aid in Producing Stream-Flow Lines and Reduce Construction Cost

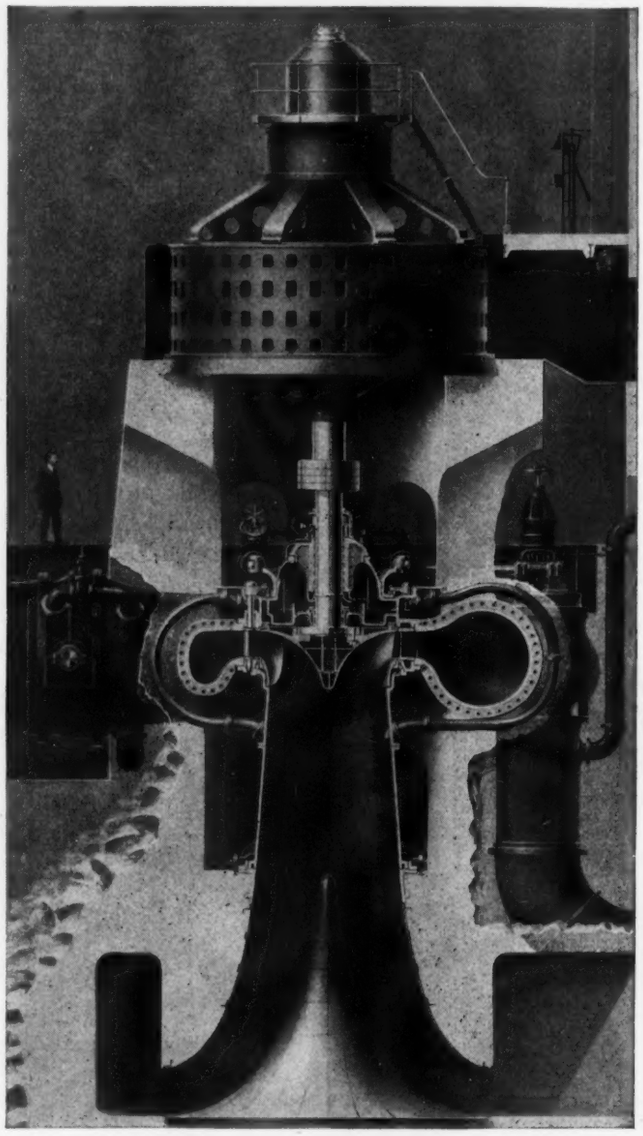
A plan which may be used for elimination of one high-tension breaker per generator-transformer unit and one breaker per outgoing line is the scheme shown on page 639. This gives the same flexibility as with two breakers, but operation is necessarily slower. Whether operating flexibility justifies the additional breakers investment is the factor that governs. With this scheme, motor-operated disconnecting switches are desirable.

Power house building design has been reduced to its simplest possible form. An example of a simple, well-laid-out power house is that shown on page 638, which is the Tiger Creek plant of the Pacific Gas & Electric Company, now under construction. It will be seen that the operating room is located in the center of the building, where the operator has a full view of the plant as well as of all outdoor equipment. Only frequently used stairways are necessary and doors opening off the operating room give access to the auxiliaries, switch cell room, storage battery room, etc. All controls, including full governor control, are centered on the switchboard, making possible the operation of such a plant (60,000 kva.) with one operator per shift.

Where there is little variation in tail-water height the generators may be mounted on pedestals, as shown in one of the accompanying illustrations, thus eliminating an extra floor in the power house at a considerable saving in expense.

In most plants two one-half capacity cranes are usually installed instead of one full capacity crane. Although the two smaller cranes cost about 10 per cent more than the larger crane, the additional cost is more than offset by a saving in building construction cost, due to the lighter columns required and the additional flexibility of two cranes over one. Moreover, since the one-half capacity cranes will handle 95 per cent of all loads, the two cranes greatly facilitate erection of machinery during construction.

Outdoor power plants are advocated by some engineers and no doubt have a field. When it is considered that the cost of the power house building is only approximately 3 per cent of the total cost of the development and that the outdoor plant represents a saving of only about 10 per cent in building and crane cost, then the difficulty and high cost of repairs, to say nothing of outage time during inclement weather, are felt by many engineers to more than offset the small saving in building cost.



Steel Draft Tube Liners Used in Place of Wooden Forms at 30 per Cent Saving in Cost

Construction Methods

From the foregoing it may be seen that if hydro costs are to be reduced it narrows down to actual construction as offering the field for greatest economy. Too much haste, lack of plans and drawings when needed, inexperienced field superintendents, lack of proper co-ordination and unwarranted accounting on the job are some of the causes of high construction costs. The most important factor of all is to secure a construction superintendent who is thoroughly familiar with hydro-electric construction and capable of running the job, give him full authority and do not burden him with red tape.

Construction equipment must fit the job and advantage should be taken of the latest and most efficient equipment available to do a particular piece of work. A minimum of temporary construction and a maximum of operating construction time both make for economy. Two shifts and occasionally three can be used to advantage, especially where expensive equipment would otherwise lie idle. Charging material direct to the job instead of carrying it in stock on the job is practiced by several utilities with resulting economy. Elaborate checking and accounting on the job requires a large field force and is said by most construction engineers to be unwarranted. Neither utility commissions nor the company's auditor require such fine details as are kept on many jobs and it is a waste of money to attempt to check every screw and bolt.

In the preliminary construction stages of a large hydro job usually rock and earth must be moved in large quantities, especially where the dam is of the rock- or earth-filled type. On the Salt Springs development of the Pacific Gas & Electric Company now under construction a rock-fill dam which will contain some 3,000,000 yd. of rock is being built. Native rock is being utilized. This is blasted off a rock cliff in large quantities, loaded into tractor-drawn trailers or electric locomotive-drawn

dump cars by electric shovels and then hauled to the dam site. Some of the accompanying illustrations show methods being employed on this job. This is the first time a dump conveyance of the Athey type has been used on a hydro construction job. The dump with tractor tread has a capacity of 20 tons and by means of hydraulic jacks the entire load is dumped from the open rear end of the hopper. Seven such pieces of equipment are being used on this job.

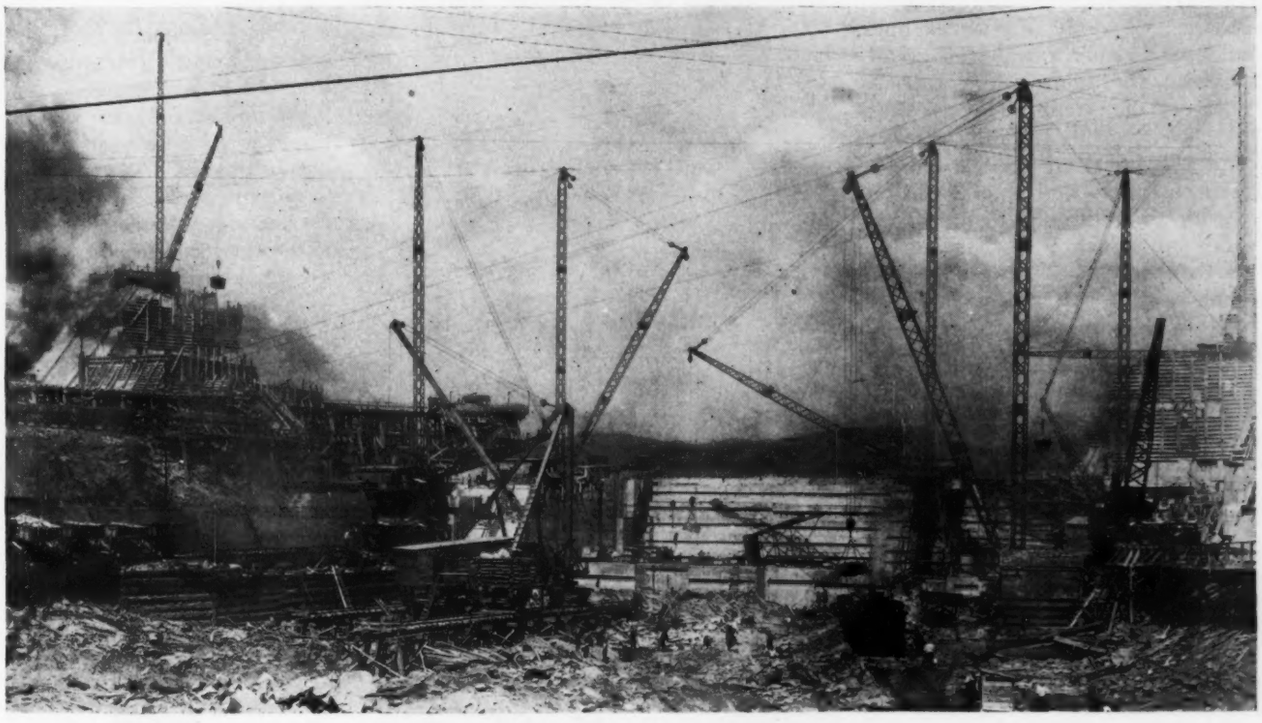
In power house erection time can be saved by installing the cranes immediately upon erection of the steel framework and then proceeding with the installation of equipment and power house building construction simultaneously. One of the accompanying illustrations of Pit No. 3 power house of the Pacific Gas & Electric Company shows the job at just this stage of construction.

Use of the Keller or slip-form method of pouring concrete in the power house structure offers a promising field for speed and economy. This method was used recently by the city of Los Angeles in the reconstruction of San Francisquito power house No. 2. In this form of construction a band of approximately 4 ft. is made for all of the walls. These forms were jacked up by means of yokes and special jacks $\frac{1}{4}$ to $\frac{3}{8}$ in. at a time, the total movement being approximately 3 in. per hour. The pouring was continuous in twelve-hour shifts and the building was poured to its fire wall in nine days. To make this method of pouring successful, pipe men, conduit men, electricians and reinforcing crews must all be alert to see that their work proceeds in advance of the concrete pouring.

Because of the large amount of hand work involved in making forms for the concrete in draft tubes for large turbines to secure the smooth stream-flow lines essential for high efficiencies, this work proves costly. On one job where draft tubes were installed for three 33,000-hp. reaction turbines using the Moody spreading type of draft tube steel liners were used at a saving of about 30 per cent over use of wooden forms. One of the accompanying illustrations shows the cone and outer liner as assembled in the shop. The cutaway illustration shows the liners as installed.

Other design features and construction methods which have effected economies might be mentioned, but those discussed should suffice to answer the question, "Can hydro costs be reduced?" It is evident that in the evolution of hydro-electric plant design certain economies may be made, and that by proper planning and execution of the work an economical development will result, but it is also quite obvious that no revolutionary or radical changes in the latest practice as discussed herein may be hoped for.

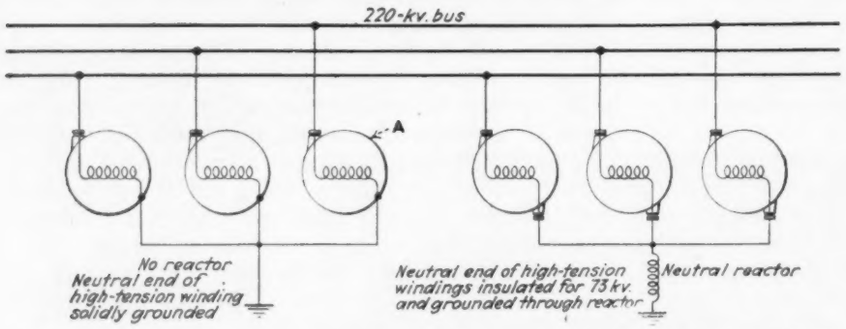
Fifteen-Mile Falls Hydro Plant Rapidly Progressing



THIS plant, which is being built by the New England Power Association on the Connecticut River in northern New Hampshire and Vermont, is a 120,000-kw. development and the largest in New England. It is the lower of two sites in this vicinity which will jointly have a combined rating of 300,000 hp. The dam at the upper site will create a reservoir which will not only benefit the Fifteen-Mile Falls plants but also other plants of the association downstream at Bellows Falls and Vernon.

A 170-ft. dam is being erected at the site shown which will enable the plant to turn out 400,000,000 kw.-hr. of primary power and 150,000,000 kw.-hr. of secondary power yearly. The Boston Edison Company has contracted for 150,000,000 kw.-hr. of the output.

Transformer Neutral Reactors Reduce Breaker Duty


220-kv. bus
A
No reactor
Neutral end of high-tension winding solidly grounded
Neutral end of high-tension windings insulated for 73 kv. and grounded through reactor
Neutral reactor

First and Second 220-Kv. Transformer Banks at Long Beach Steam Plant

The first with solidly grounded neutral and the second with neutral reactor to limit ground fault currents.

SINCE records of 220-kv. flashovers on the system of the Southern California Edison Company show that practically all are ground faults, limitation of fault currents through transformer neutrals is of primary importance. With an ultimate of eight 100,000-kva. units at the Long Beach steam plant it was evident that if transformer neutrals were all solidly grounded, neutral fault currents at this plant, as well as at all 220-kv. substations at the receiving end of the Big Creek lines, would reach such a value as greatly to exceed the interrupting capacity of present oil circuit breakers.

To keep ground fault currents within the limits of the capacity of present breakers and thus avoid the necessity of replacing them, it was decided to insulate the neutral side of all future 220-kv. transformers to such a value that it would be possible to keep ground currents within safe limits by the use of reactors in transformer neutrals.

Present 220-kv. transformers on the Edison system are of the single-bushing type, making necessary a solidly grounded neutral. Use of neutral reactors will make it necessary that all future 220-kv. transformers be insulated for 73 kv. at the neutral end of the high-tension winding, this being the maximum voltage above ground that can be reached by the neutral of a 220-kv. bank when operated on the same bus with a solidly grounded bank providing the impedance value of the neutral reactor is properly chosen. Impedance of reactors will depend upon system location and connections and will have to be determined for each transformer installation. In the case of the transformer bank now being installed for the second 100,000-kva. unit at Long Beach impedance of the neutral reactor is of such a value that ground current under normal system conditions will be limited to a low value and potential to ground will not exceed the 73 kv. for which the neutral end of transformer windings is insulated.

By starting now and continuing this practice the interrupting capacity of present breakers at Long Beach as well as those at nearby 220-kv. substations will be sufficiently high to handle ground fault currents with the ultimate installation of eight 100,000-kva. units at Long Beach. This means a great saving as compared with replacing many of the present breakers. Moreover, system stability will be improved greatly, due to reduction of ground fault currents.

Insulating transformer neutrals for full line voltage to make possible complete isolation of the neutral to accomplish the same purpose would have increased the cost of transformers by approximately 3 per cent and reduced the efficiency by approximately 1 per cent as against using the neutral reactors.

Cranes Reduce Manhole Costs

ONE of the Greater New York companies has cut manhole capital costs through effective use of cranes from the excavation to placing the cover over the finished installation. Three Universal cranes dig the holes and load excavated earth into trucks. Three Load Master cranes (3,000 lb.) pull sheeting, lift stone and castings and lower transformers. An estimate was made before the purchase and this showed a significant saving. The experience gained with use shows they paid for themselves in six months and have cut manhole costs 30 per cent. One crane would be justifiable for a company having enough subway work to keep 1,000 laborers busy for four months. On one occasion one of the Universal cranes lowered fifteen 9½-ton, 500-kva. transformers into fifteen scattered manholes in thirteen hours aggregate time. Three trucks were kept busy delivering the transformers. The

Universal 10-Ton Crane on 7½-Ton Mack Truck

Load Master Crane

cost for placing all fifteen transformers was only 75 per cent of the price bid by a contractor to install one transformer.

Heavy ornamental street light standards are also set by means of the crane.

Hydraulic Press Aids Bus Construction

A HYDRAULIC press formerly used to force wheels on axles has been pressed into a new useful service by the Syracuse Lighting Company. It is being used extensively to flatten bus tubing for terminals. In erecting one substation, some 400 ends of tubing had to be flattened and drilled for bolts. The press was used in preference to the slower heat-and-sledge method with a resulting saving of 4 per cent in the labor item on the station. It is also used to press flat terminals onto ground leads, etc., by slipping tubing over the tinned end of the flexible conductor and then pressing flat. No solder is used and therefore no risk of having it melt out under heavy current flows.

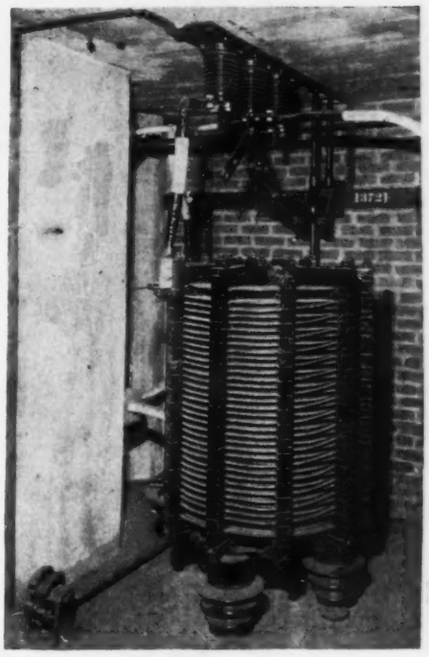
Still another use to which the press is put is to offset flat busbar at splice points. It gives a straight run with two less dummies and four less contacts to increase the resistance of the joint.

The variety of uses to which this hydraulic press was applied indicates how the return on other investments may be increased by studying operations which may be performed by infrequently used equipment.

Utilizing Space in Electrical Galleries

IN ONE generating station of recent construction where the phases are isolated up to the outgoing cables the arrangement shown is employed to utilize most efficiently the space in the electrical galleries. Only one phase is shown, the other phases being accommodated on different levels. Duplicate ring buses with selector switches are used, hence the four breakers shown. The two outer breakers are connected with the same bus; likewise the two inner breakers.

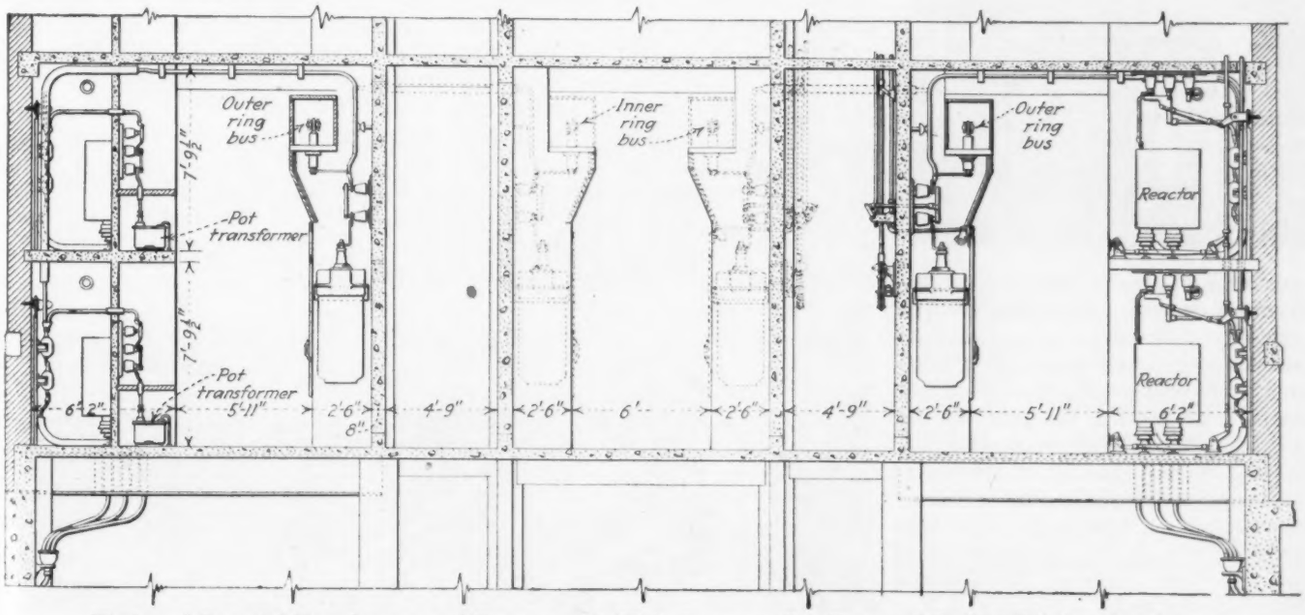
Potential Transformer with Fuse Above Partition



Reactor and By-Pass Switch Operable from Front of Cell

This section applies only to two circuits.

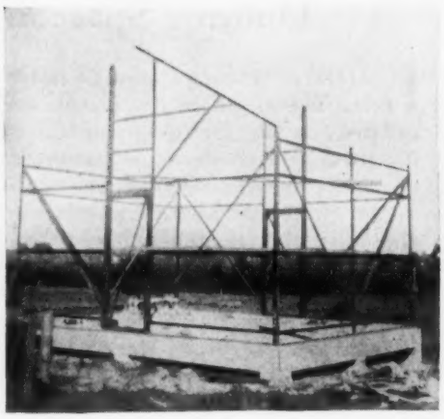
The chief space-saving feature is the stacking of reactors and potential transformers with their respective fuses and disconnects in tiers. It may be observed that the by-pass switches for the reactors may be operated from the fronts of the compartments and that all equipment and circuits are readily accessible. This equipment is accommodated in a cross-section measuring 52 ft. 4 in. wide by 16 ft. high.



Tiering of Potential Transformers and Reactors with Their Corresponding Fuses and By-Pass Switches Saved Space

Pole Height Increased for Joint Use

THE pole shown in the accompanying illustration was set in 1926 by the Scranton Electric Company with ample clearance for the wires. But in August, 1928, it became necessary to adapt this pole for joint use by the telephone company. It did not provide sufficient clearance for the installation of the telephone cable and it seemed as if a new pole, longer by 5 or 6 ft., would have to be set instead of the shorter pole, with considerable expense for this changeover. However, experience with Williams pole mount construction led the Scranton Electric Company distribution department to believe that the necessary extra length for proper clearance could be obtained by jacking the pole up out of the ground and supporting it entirely above ground on the precast concrete base typical of such construction. Accordingly, this was done, with a saving in money and time; besides, further ground-line decay was avoided.



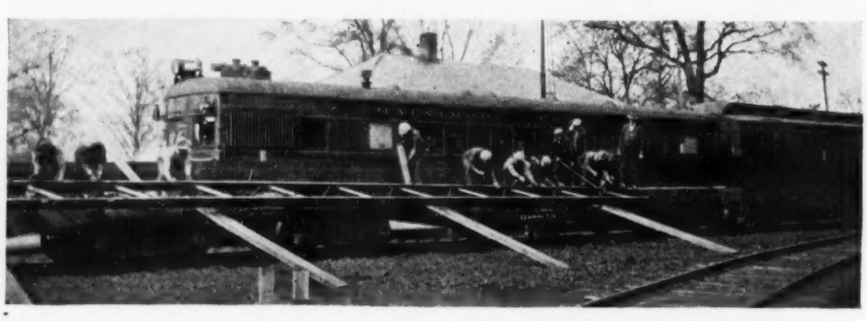
Asbestos Panels Speed Switch House Erection

IN LOCALITIES where external appearance is of minor importance the use of asbestos paneled switch houses has made considerable headway in one engineering organization on account of their speed of erection, moderate cost as compared with concrete or brick and their fireproof qualities. The steel framing required for one such house, which is provided with a concrete floor and mat with recessed edges into which the asbestos panels fit for watertight service, is shown in the accompanying illustrations. The house contains an installation of oil switch equipment, current transformers, regulating apparatus, battery, etc., as required. The panels overlap to the extent of a few corrugations to insure weatherproof service and the houses cost far less than concrete or brick.

Fast Work on Pole Distribution

SPRING, in spite of its joyous aspects, is not a good time of year to undertake transmission line construction on private right-of-way. Hauling in poles and towers with heavy trucks and trailers over soft fields whose earth has just been released from the grip of frost is not an easy nor a fast job, nor does it endear the power company to the property owners. The Dayton (Ohio) Power & Light Company had a 15-mile, 33-kv., single-circuit line to build and of this about 6 miles was on private right-of-way paralleling the Baltimore & Ohio Railroad, says T. E. Bennett, superintendent of line construction. The pole locations were about 6 ft. outside the boundary fence along the railroad right-of-way.

It was not practicable to send trucks along the railroad and it was almost as impracticable to run them across the fields. Teams and sleds appeared to be about the only way to get the poles to their locations. Instead of this recourse, however, it was decided to try another way. The poles were Archbold-Brady channel type. The 87 poles were loaded on six flat cars for the 6-mile run and a work train was hired from the railroad for $165 per day to haul the loaded flats out on the line. The train stopped every 400 ft. for a pole to be skidded off. A gang of men followed the train and picked up each pole and dropped it over the boundary fence exactly where it should go.

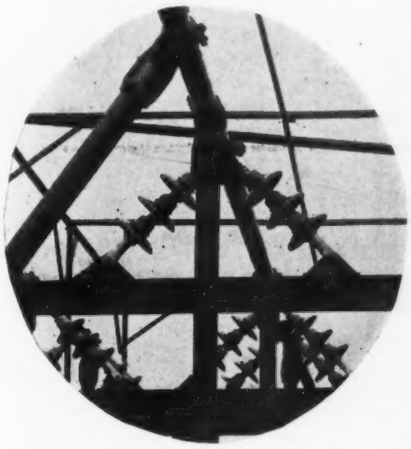


Clamped Bus Connections

THE time and labor savings which may be realized through the use of clamp connectors for high-tension buses as compared with the older type of shrink-fit equipment are illustrated by the recent experience of the West Kootenay Power & Light Company of British Columbia in the assembly of 500 electrical connections.

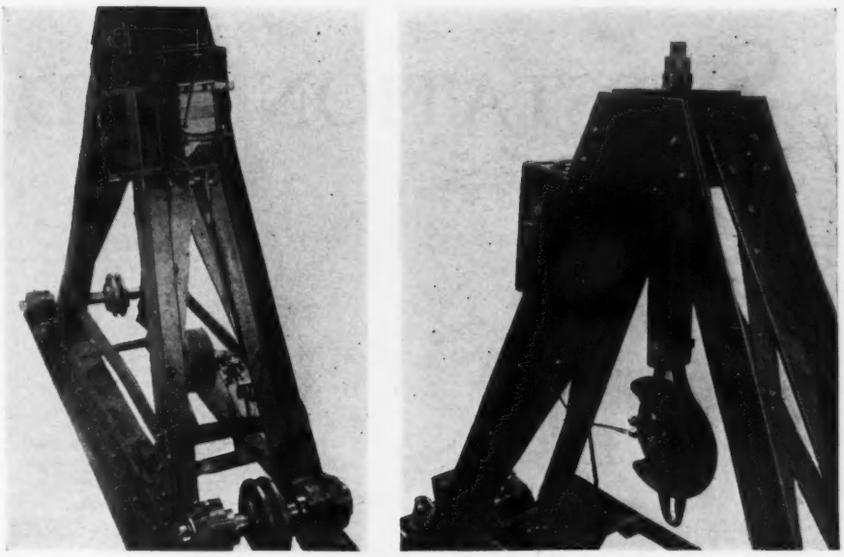
It required 30 minutes per shrink-fit joint installation as against ten minutes per clamp joint. Services of three men were needed to complete the former, while only two were involved for the latter. Clamping was also favored by not requiring heating equipment, soldering or abrasives. The bus was not, of course, annealed and the salvage value of the clamp connectors is 100 per cent.

The quality of the connection effected with a shrink fitting has proved questionable, according to A. B. Dibner of the Burndy Engineering Company, Inc., for too rapid cooling of the solder, the degree of



accuracy of the slip joint and degree of annealing, with consequent loss of rigidity, leave results somewhat indeterminate.

With clamp joints the degree of tension of the bolting wrench offers a direct indication of the pressure of the clamp connector on the bus. For 2½-in. copper tubing this has been established as 20 tons.



Front and Side Views of Cable-Pulling Dynamometer with Graphic Meter Adapted to Make Damped Chart of Cable Tension

Longer Duct Runs Made Possible with Dynamometer Control

A 45,000-VOLT transmission feeder, consisting of three single-conductor, 200,000-circ.mil, lead-covered cables, each approximately 1.8 in. in diameter, installed in one 5-in. duct, was recently placed in service by the Westchester Lighting Company. As this cable was to be equipped with oil pressure reservoirs and the duct was practically in a straight line the manholes were placed at a greater distance apart, which not only reduced the number of manholes and reservoirs but the number of splices, in which the greater percentage of faults occur usually.

The maximum duct length in this new system was 1,002 ft. and before the installation of the cable some experimenting was done. To get an accurate observation of the stresses involved a special recording cable pulling stress indicator was constructed which is shown in the accompanying illustrations.

The framework of this instrument is similar to ones previously used, but the recording device as designed and built by the electric meter and test department of this company is believed to be entirely new. It embodies a reconstructed graphic meter, the pen of which is connected by means of a flexible cable to the moving hand of the dynamometer through bevel gears to give approximately ¼ in. per 1,000 lb. on the stress scale. The graphic chart is fed in a similar manner by bevel gears and a flexible cable connected to a pulley bearing on the steel-pulling cable. This is designed to move the chart 1 in. for every 20 ft. of cable passing through the dynamometer.

Due to the truck vibration, it was necessary to apply spring tension to the pen to hold it firmly against the moving chart. The accompanying chart, taken on the 1,002-ft. section, shows a maximum stress of 6,400 lb. With proper lubrication and careful feed of the cable comparatively smooth curves are produced by this device and in all cases gave assurance of the fact that the maximum stress recommended by the manufacturer had not been exceeded. The feasibility of such long pulls is dependent, of course, on duct design.

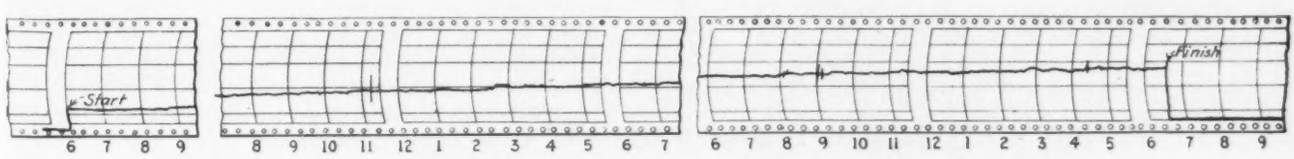
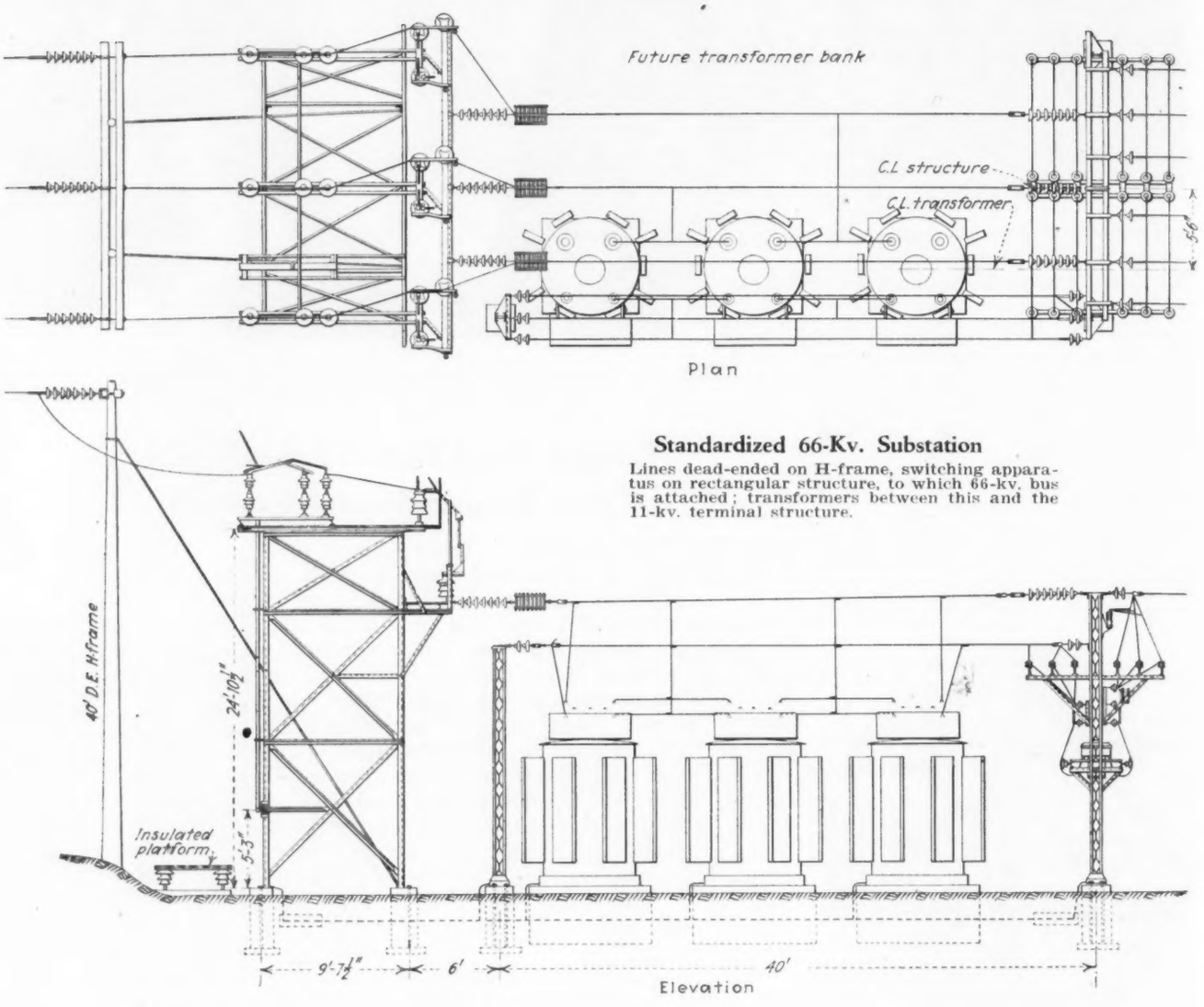


Chart Shows Initial Pull of About 1,500 Lb. and Maximum of 6,400 Lb. at Finish

SUBSTATION AND SWITCHING S



Standardized 66-Kv. Substation

Lines dead-ended on H-frame, switching apparatus on rectangular structure, to which 66-kv. bus is attached; transformers between this and the 11-kv. terminal structure.

ECONOMIES have been effected in substation and switching structures by the Niagara, Lockport & Ontario Power Company by simplifying the arrangement and standardizing on the component parts. As far as possible a standard column and beam are used in the rectangular structures for 66-kv. and 110-kv. stations. For transmission line crossings over railroads one standard tower has been developed which is a composite of the several railroad specifications to be met. These parts are either kept in stock or readily obtained on tonnage bids from structural steel dealers.

In the 66-kv., 6,000-kva. substation shown no provision is made for high-tension circuit breakers or for a switching bus for the transformers. In case a transformer fails the line is killed and cut and the transformer replaced by the spare.

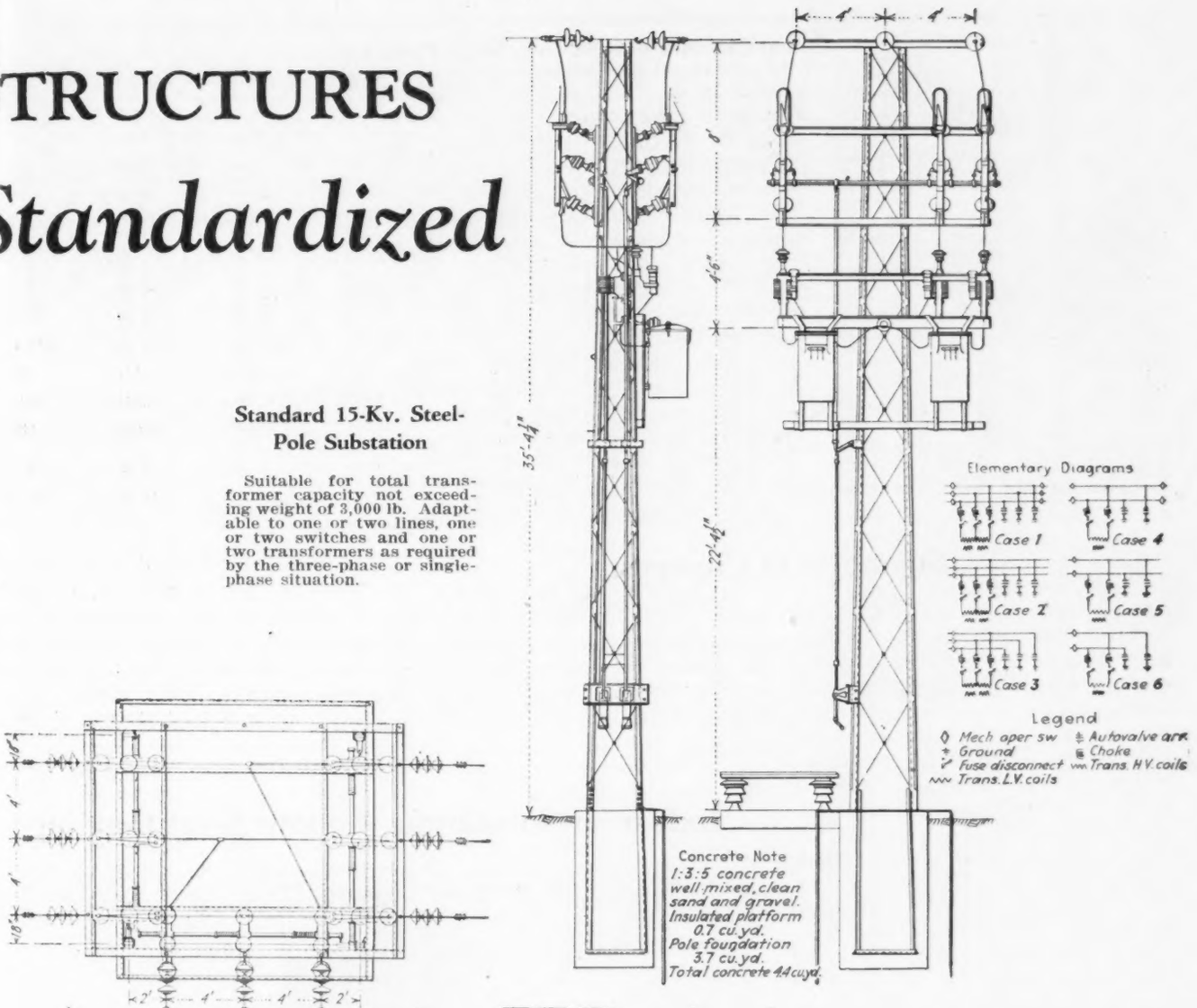
Switching structures for three or four lines have also been standardized with the aim of simplifying the arrangement and minimizing the number of insulators and disconnects and also minimizing the labor and material on buses.

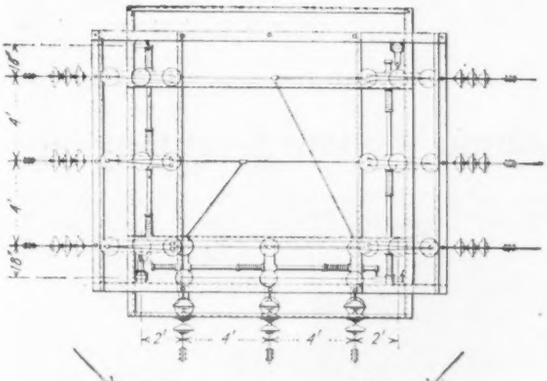
For 15-kv. substations of 50 kva. or less capacity (two 25s in open delta) a standardized steel pole is used as shown. This same structure is employed as a line cut-out tower without transformers.

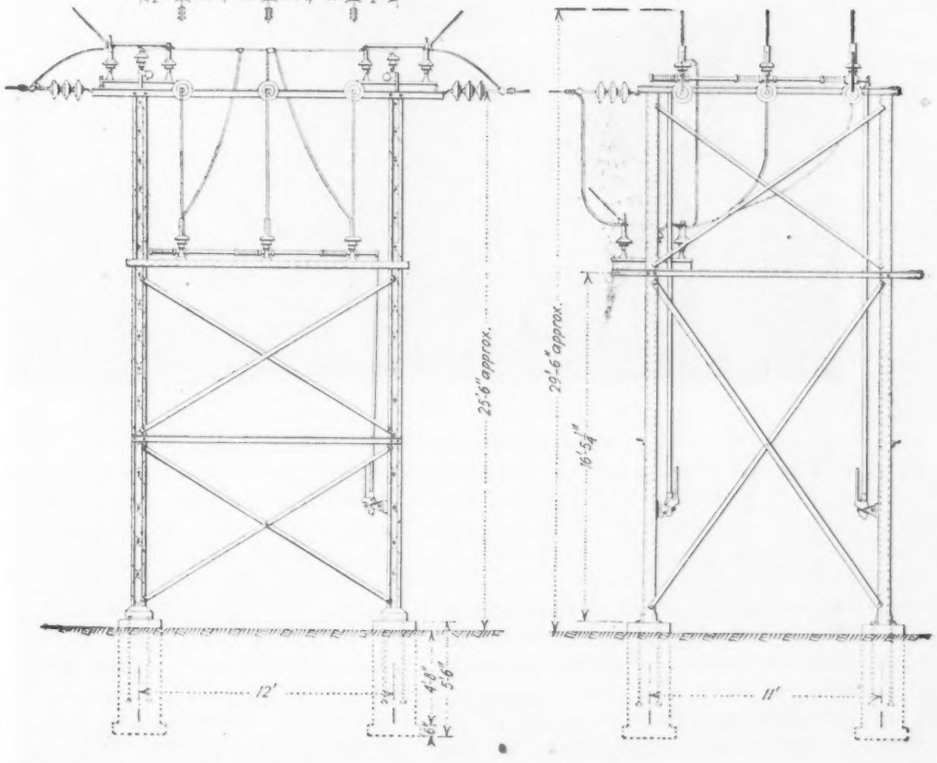
G STRUCTURES *Standardized*

Standard 15-Kv. Steel-Pole Substation

Suitable for total transformer capacity not exceeding weight of 3,000 lb. Adaptable to one or two lines, one or two switches and one or two transformers as required by the three-phase or single-phase situation.







Standard 33-Kv. Switching Structure

Suitable for three or four lines. All switching on the one rectangular structure. Dead-end lines of smaller than No. 2 B & S copper. Larger conductors are dead-ended on adjacent line structure and spans left slack.

Cost of One Mile of 6,600-Volt, Single-Phase Line

(Right-of-Way Cost Omitted)

	No. 1 25-Ft. 7-In. Poles 150-Ft. Span No. 6 Wire		No. 2 30-Ft. 7-In. Poles 200-Ft. Span No. 4 Wire		No. 3 35-Ft. 7-In. Poles 250-Ft. Span No. 4 Wire		No. 4 35-Ft. 8-In. Poles 250-Ft. Span No. 4 Wire	
	No.	Cost	No.	Cost	No.	Cost	No.	Cost
Poles								
Western red cedar								
½-in. butt	32	$240.00	27	$297.00	21	$283.50	21	$336.00
Penetration	4	44.00	..	.....	..	.....	..	.....
Arms								
3½x4½x67 in.	38	24.05	29	18.36	23	14.56	23	14.56
Pins								
1½x9 in. Locust	72	2.88	58	2.32	46	1.84	46	1.84
Hardware								
⅝x4½-in. C. B.	72	2.88	58	2.32	46	1.84	46	1.84
⅝x12-in. M. B.	34	4.08	25	3.00	19	2.28	19	2.28
⅝x16-in. M.B.	2	0.28	2	0.28	2	0.28	2	0.28
⅝x16-in. D. A.	4	0.64	4	0.64	4	0.64	4	0.64
⅝x4-in. lags	50	2.00	66	2.64	54	2.16	54	2.16
28-in. braces	72	7.92	58	6.38	46	5.06	46	5.06
2x2-in. washers	88	1.76	70	1.40	59	1.18	59	1.18
6-in. pole shims	10	1.00	10	1.00	10	1.00	10	1.00
3-bolt clamps	4	0.92	4	0.92	4	0.92	4	0.92
Anchor rods	2	1.40	2	1.40	2	1.40	2	1.40
Anchors	2	4.50	2	4.50	2	4.50	2	4.50
⅜-in. guy strand	80 ft.	1.44	80 ft.	1.44	100 ft.	1.80	100 ft.	1.80
Insulators								
7,500-volt pin	72	18.00	58	14.50	46	11.50	46	11.50
7,500-volt strain	2	1.09	2	1.09	2	1.09	2	1.09
Conductors								
Str. copper	†871	161.14	†1,367	252.30	†1,367	252.30	†1,367	252.30
No. 4 soft solid	†20	3.70	†22	4.07	†22	4.07	†22	4.07
Sleeves	8	0.56	2	0.20	2	0.20	2	0.20
Labor	....	196.00	....	178.00	....	165.00	....	165.00
Miscellaneous	....	80.00	....	80.00	....	80.00	....	80.00
Total		$800.24		$873.76		$837.12		$889.62
Relative capacity, per cent		100		144		144		144
Bending moment, 3PH basis		8,153		13,931		20,473		20,473
Resisting moment, 3PH basis		14,500		17,800		21,600		30,800
Permissible butt rot to maintain F.S. of 2, in.		0.79		0.39		0.10		0.74
Maintenance per mile per year		$25.00	†Lb.	$21.00		$16.50		$16.50

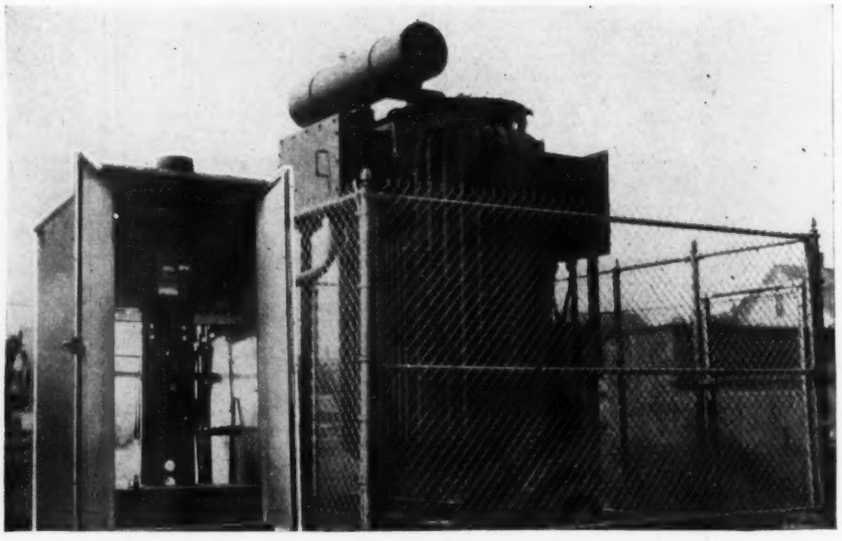
Strongest Is Cheapest

A LINE more than twice as strong, having the same factor of safety, with half again the capacity and costing one-third less for maintenance than previous construction, was discovered to be possible at 11 per cent additional cost by the Iowa Public Service Company after a critical examination of its transmission practices, according to G. A. Neal, vice-president Iowa Public Service Company, Sioux City, Iowa. The tabulation here reproduced shows the development of the practice of this company from the initial No. 6 conductor on 25-ft. poles spaced 150 ft. through No. 4 wire on 30-ft. poles at 200 ft. and 35-ft. class C poles at 250 ft. to the final standard of class B poles of the latter height and spacing.

The 6,600-volt line, cost figures of which are given, is a common type of construction on the company's system, which serves 175 cities, towns and hamlets. So far as the cost increase of $89.38 between the first and fourth constructions is concerned, it is more than accounted for by the difference between $161.14 and $252.30 for No. 6 and No. 4 conductors. This change would have had to be made in any event because the smaller wire was insufficient for good regulation on the growing loads of the system.

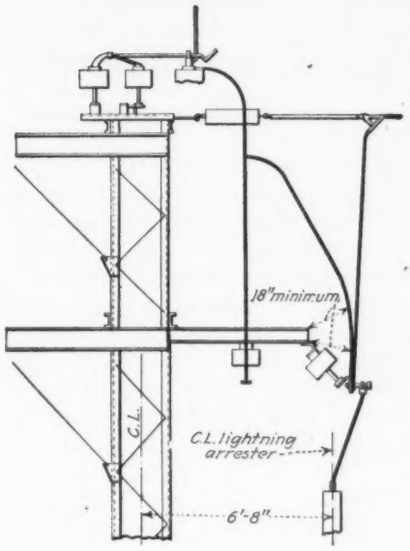
The figure of $8.50 saved on maintenance per mile of line per year only feebly expresses the improvement brought about by the new type of construction. This improvement is implied by the change to larger top poles at the 250-ft. spacing in the increase of resisting moment from 21,600 to 30,800 lb.-ft. For about 100 days in the year many of the county and section line roads of western Iowa are virtually impassable to motor travel and only with difficulty negotiated by horse-drawn vehicles. Sleet and high winds are frequent. A number of the heavier built lines have already passed through one winter and on not one of them was there a service failure caused by inability to withstand stormy weather.

Industrial Substation Without Steel Framing



A TYPE of industrial substation which is being utilized more and more on the Tenney properties north of Boston, Mass., is illustrated above. The major features are the supply and delivery of energy by underground lines, the use of rigid conduit for all exterior wiring, absence of all exposed contacts and the mounting of the circuit breaker, relay and metering equipment on panels within a metal-clad housing that is provided with front and rear doors for easy access outside the inclosure for the transformer. The example shown supplies energy to the Converse Rubber Shoe Company from the Malden Electric Company system and is automatic in operation and unusually safe from the standpoint of both the customer and the public. All buses are eliminated and the insulator requirements are also practically nil.

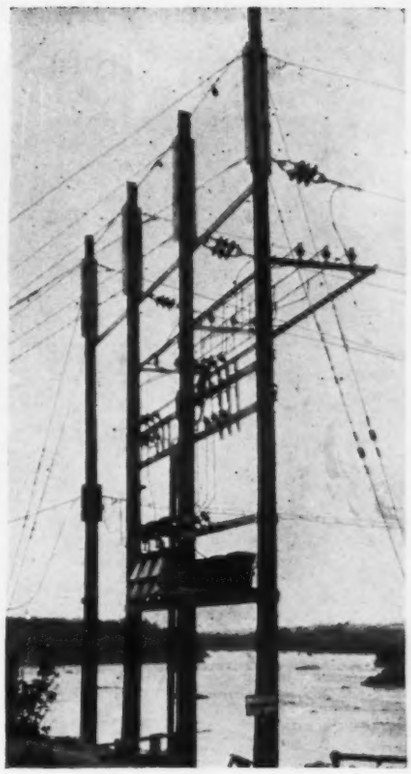
Sharp Bends in Leads Replace Choke Coils



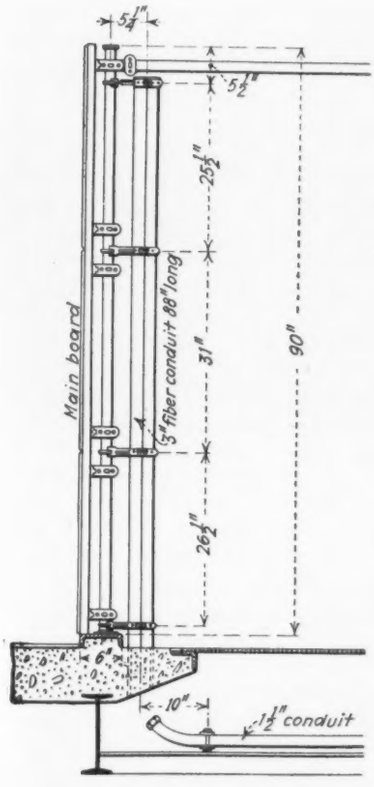
CHOKE coils have been eliminated in 25-kv. circuits of the West Penn Power Company because of their questionable value and also because of troubles experienced with them, according to G. C. Pugh, assistant substation design engineer. Instead, the incoming line passes through a strain clamp and drops directly to an insulator mounted above the lightning arrester. One of the bolts in the insulator clamp is allowed to extend about 6 in. so the lightning arrester disconnect clamp may be fastened to it. This, incidentally, provides a very simple method of removing the lightning arrester from service. A piece of copper tubing runs back parallel to the line lead in V formation and finally taps a conductor which runs between the line disconnect of the oil circuit breaker and by-pass disconnecting switch.

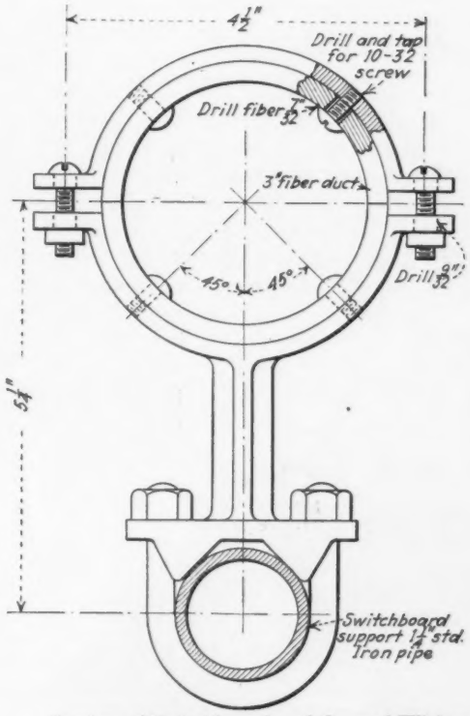
The sharp bend in the circuit formed by this construction has sufficient impedance during surges to choke back disturbances and allow them to discharge through the lightning arrester without incurring the operating difficulties experienced with choke coils. Furthermore, it costs less to install and maintain.

Dead-End Tower Serves Several Duties



AT A river crossing outside an Eastern hydro-electric station the generator leads and control wiring are carried across the stream to an older plant from which supervisory control is exercised. The terminal tower structure illustrated dead-ends the conductors, carries a three-phase bus set, lightning arrester taps and units, supports a bank of station service transformers and provides for ready connection to an underground duct line leading from the station. Only four wooden poles were required and a few standard structural steel members sufficed to provide cross-bracing, insulator supports and pole top stiffeners.





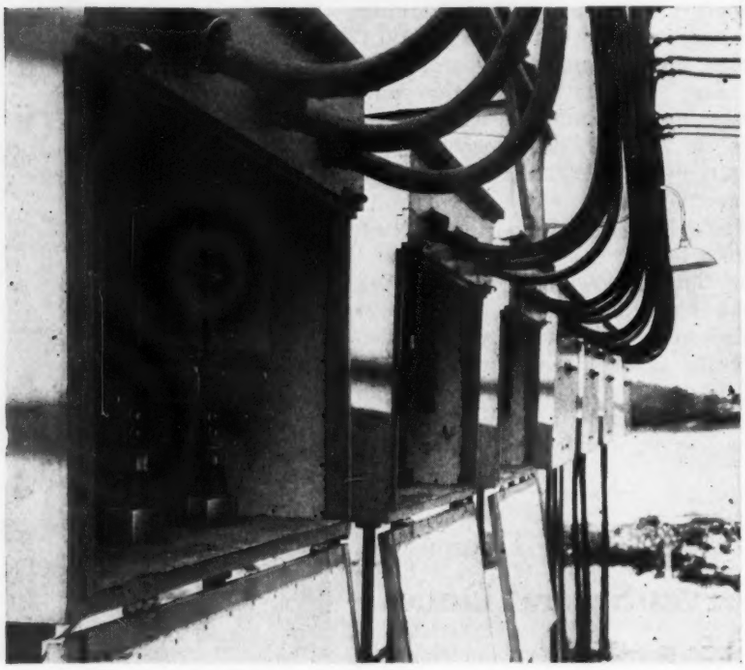
Section of Switchboard and Control Wiring Duct and Clamp for Attaching Fiber Duct to Pipe Supports

Split Fiber Duct Expedites Control Wiring

FROM one and one-half to two switchboard panels can be wired in the time formerly taken to wire one on a power system which employs split fiber duct behind the board in place of the former method of attaching control and instrument wiring by cleats to the backs of the panels.

The fiber duct is split vertically throughout its length and each wire is brought out to the proper terminal point through a small hole or slot drilled in the duct. The ducts are attached to the switchboard pipe supports by a special clamp detailed in the accompanying drawing. The scheme renders the wiring remarkably accessible and leaves ample space at the rear of the panels for both construction and maintenance activities.

Heavy-Duty Fuse Box Designed from Standard Parts



IN CONNECTION with the distribution of 600-volt energy from a 3,000-kva. industrial substation serving the Robert Gair Company, Montville, Conn., the engineering department of the Connecticut Power Company designed a 600-amp. fuse box to facilitate sectionalizing seven feeders at the low-tension bus. No 600-amp., 600-volt fuse box could be found among standard catalog material at the time. Asbestos-lined boxes were assembled and standard Delta-Star contact clips utilized from indoor disconnecting switches, these being mounted on standard low-tension porcelain pillars and fitted with cartridge fuses of standard design.

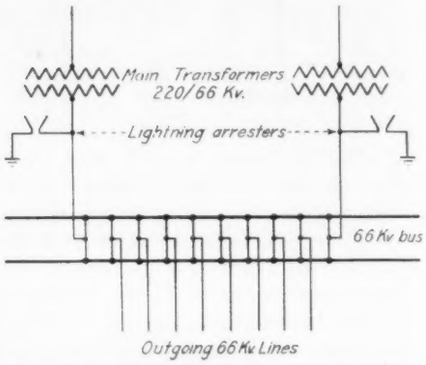
Smaller Truck Does Better Job

MUCH has been done to make line truck assembly compact, convenient and efficient. The New York & Queens Electric Light & Power Company has found it possible to make a 2- to 3-ton truck with pneumatic tires, four-wheel brakes and seven-speed do all that was formerly done with a 3½- to 5-ton truck with solid tires. In spite of the decrease in weight and length (3½ ft.) the traction for heavy pulling is superior, largely because of the slow speeds and tire contact area available. The digging bars, jacks and center leg of derrick are carried under the rear end. Nothing is carried on the floor of the truck except transformers, wire, etc., to be installed on the job.

3½ - Ton Truck Matches 5-Ton in Carrying and Pulling Capacity

Line Arresters Eliminated

IN SEEKING further economies in substation design, engineers of the Southern California Edison Company believe that the number of lightning arresters required can greatly be reduced without sacrificing safety, according to F. H. Mayer, department of engineering design, Southern California Edison Company, Los Angeles, Calif. It has been known for some time that the bus and transformers are reflecting mediums for lightning and high-frequency disturbances resulting in the highest voltages occurring at the point of reflection. The fact that lightning arresters are installed primarily to protect major equipment and the fact that the point of reflection is at the transformers has led to a decision to install arresters at this point and eliminate all arresters on lines at a new 220/66-kv. substation now under construction.



Since Transformers Are the Point of Reflection, Lightning Arresters Are Omitted on Individual Lines and Installed as Shown

In this particular station it is believed that two sets of arresters will afford the same degree of protection as would fourteen sets on the individual lines, thus resulting in a large saving. With an ultimate of four transformer banks and 30 66-kv. lines for this station, this change in lightning arrester policy will mean a saving of approximately $90,000. Moreover, elimination of line arresters has made it practicable to adopt a simplified type of 66-kv. rack similar to that used by the Edison company for 220 kv., thus effecting further large economies.

News of the Industry

N.E.L.A. Formally Selects San Francisco

Convention of 1930 Will Be Held There in Week Beginning June 16—Question of Manufacturers' Exhibition in Abeyance

AT A MEETING of the executive committee of the National Electric Light Association held in Chicago on Wednesday of this week it was voted to hold the next annual convention of the association in San Francisco during the week beginning June 16, 1930. Whether or not an exhibition will be held in connection with the convention has not yet been decided. The manufacturers are willing to provide an exhibition, and the association is anxious to have one if suitable accommodations can be obtained. At present consideration is being given to the erection of a temporary exhibition hall adjacent to the auditorium in San Francisco's civic center. Final decision on the matter was left with the officers of the association.

Southern California Edison Again Reduces Rates

Rate reductions that will result in a saving to its 427,000 customers aggregating $1,400,000 a year have been announced by the Southern California Edison Company with the approval of the California Railroad Commission and will become effective November 1.

In the company's geographic districts known as Alhambra, Compton, Inglewood, Long Beach, Monrovia, Montebello, Pasadena, Redondo, San Fernando Valley, Santa Monica and Vernon, in which congested territory the company's local expenses per consumer are lowest, the new maximum lighting rate will be 5 cents per kilowatt-hour as compared with the present rate of 5.6 cents.

In the geographic districts known as Covina, Fullerton, Huntington Beach, Ojai, Ontario, Oxnard, Pomona, Redlands, San Bernardino, Santa Ana, Santa Barbara, Santa Paula, Ventura and Whittier, where the local expenses are somewhat higher than in the congested area above mentioned, the maximum lighting rate will be 5.3 cents per kilowatt-hour as compared with the present rate of 5.6 cents.

In the geographic districts known as Big Creek, Delano, Hanford, Lancaster, Lindsay, Porterville, Tulare and Visalia, where the local expenses per consumer are highest, the maximum lighting rate will be 5.6 cents per kilowatt-hour as compared with the present rate of 6 cents.

The growth of the load supplied by the Department of Water and Power in Los Angeles has resulted in a very considerable increase in the energy supplied by the company to the department. Accordingly a new schedule will be made, effective November 1, which will result in a lower rate to the city for increases in its use of energy from the company. Consideration is also being given to modification of the industrial power rates in the congested area, and it is expected that when studies now being made by the engineers of the Railroad Commission and of the company are completed, probably about the first of the year, such a modification will be put into effect.

In 1927 the Southern California Edison Company, with the approval of the Railroad Commission, reduced the maximum lighting rates in the belief that such reduction would stimulate sales of electrical energy for household purposes and would further reduce service costs. It was in the nature of an experiment at that time. Experience under the reduced rates has proved that the lower rates have resulted in greatly increased use of electrical energy.

I. E. S. Has Biggest Meeting Yet

Philadelphia Convention Stages Preliminary Session on Central Station Lighting—Great Variety of Subjects Ably Treated in Four Following Days

MORE than 625 members and guests of the Illuminating Engineering Society registered for the twenty-third annual convention of that organization, held in Philadelphia this week, the largest number that has ever attended a meeting of that society.

An innovation in this year's program was a pre-convention session for central-station lighting service engineers. At this session it was brought out that electric utility commercial men need not feel that undue concentration will be devoted to building up domestic business to the exclusion of other sales activities, because the illuminating engineers are on record to see that the lighting of great buildings, shops, factories and highways is not only kept up with the best practices of the day but that such structures are adequately wired to meet the mandates of the future.

A symposium based upon a questionnaire submitted to seven utility companies gave an indication of probable costs to increase domestic sales. Several organizations figured that 10 to 20 per cent of an estimated increase in revenue might be justifiably expended to obtain that increase.

In speaking of general promotional lighting activities A. A. Brainerd, Philadelphia Electric Company, said: "Since the central station receives the greatest benefit from high-quality lighting, it must be expected to bear the lion's share of the expense. I believe that the logical plan for the most efficient lighting service would be to have all interests involved pool their lighting specification work through the local electrical league in such a manner that the central-station lighting service department will do the major part of the engineering work." Mr. Brainerd also suggested that "in the future we should place more effort on selling lighting as a complete system in the sense that ventilating and heating is a complete system." "We need," he said, "lighting systems instead of installations, foot-candles instead of watts."

An entire session of the convention proper was devoted to "Light's Golden Jubilee," C. H. Sharp acting as chairman. H. P. Liversidge, ex-president of the Association of Edison Illuminating Companies, presented the lamp committee's report of that organization, which includes references and quotations to indicate the status of many pioneers in lighting work. Dr. Elmer A. Sperry, E. J. Cattell of Philadelphia and Representative C. A. Eaton gave reminiscences of the inventor and paid tribute to him.

An analysis showing the relation of light to power in twenty industrial plants was offered by H. E. Cook, Detroit Edison Company, at the Wednesday session. Mr. Cook concluded that "power installations are in general constant in capacity, whereas lighting affords a variable and hence an opportunity for additional revenue through the increase which is procurable by increased efforts at saturation on the part of the serving utility."

Leroy E. Kern, an architect, pointed out that in any endeavor by utility or fixture organizations to supply service to architects in suggesting layouts or effects it must be kept in mind that any free service must be wholly without concomitant obligation upon the architect. In this connection E. A. Brand, New York Power & Light Corporation, found the natural answer in a lighting and wiring service department to cooperate fully with the architect and general contractor on every new or remodeling project in the territory served. This department should be non-commercial. F. Vogel, architect, said that 90 per cent of the cases in question

could be taken care of by the preparation of standard data and specifications and suggested such a codification.

The possibilities of electrical advertising and a plan involving the placing of a sign manufacturers' representative on the utility pay roll were suggested by C. R. Tracy of the Sioux City Gas & Electric Company. A street-lighting plan for business districts based upon increased valuation of property benefited was discussed by W. T. Blackwell, Public Service Electric & Gas Company.

At the lighting practice session on Thursday Charles J. Stahl, Westinghouse Electric & Manufacturing Company, described equipment and effects at the Barcelona international exhibition; D. W. Atwater, Westinghouse company, offered suggestions as to the design and installation of lighting demonstrations, while other papers covered theater lighting, South African practices and spectacular lighting for the Canadian National Exhibition.

J. L. Stair, Curtis Lighting, Inc., talking at this session of the new lighting art and its permanent value in the cumulative development of illumination work, pointed out that the greatest danger lies in the tendency on the part of mediocre designers to include factors of glare. A spectro-photometer for the measurement of reflection values was discussed by S. G. Hibben, Westinghouse company; M. Luckiesh and F. K. Moss, National Lamp Works, General Electric Company, in a paper entitled "A New Science of Seeing," discussed individual physiological responses.

Two sessions were devoted to the consideration of daylighting factors, designs and practices in illuminating engineering work, effects of ultra-violet radiation and the influence of window materials, synthetic sunlight and photoluminescence.

Entertainment features included the president's reception, a visit to P. S. du Pont's illuminated fountain and gardens, a banquet on Thursday evening and a golf tournament. Officers for the coming year were announced as follows: President, H. H. Magdsick; vice-presidents, W. F. Little and Julius Daniels; treasurer, C. L. Law; general secretary, E. H. Hobbie.

International Paper & Power's Coming Hydro Plants

Testifying at Macon, Ga., on Tuesday in a suit concerning the International Paper & Power Company's newspaper investments, from all of which the company has withdrawn or is seeking to withdraw, A. R. Graustein, the president, said incidentally that his company had an undeveloped project by which 500,000,000 kw.-hr. or 600,000,000 kw.-hr. a year would be generated from additional hydro-electric plants on the Hudson River in New York made possible by several new dams. Later statements from the company's office implied that this plan was still one for the future, not the present. Mr. Graustein put the output from a development his company is now beginning on the Santee and Cooper Rivers in South Carolina at 400,000,000 kw.-hr. He denied that the International Paper & Power Company and New England Power Association were connected with any other power group by affiliation or interlocking directorates.

Dearborn Program Simple

Re-enactment of Scene in Menlo Park Laboratory 50 Years Ago with Edison as Chief Figure Will Be Climax —Celebrations Elsewhere.

SIMPLICITY will mark the observance of the fiftieth anniversary of the invention of the electric lamp when it culminates at Dearborn, Mich., under the direction of Henry Ford on October 21. Official announcements say that members of the party of electrical pioneers and leaders specially invited by Mr. Ford will be brought from Detroit to Dearborn on the afternoon of October 21, traveling on a 50-year-old train. During the day the Edison School and Museum will be visited along with the typical American village. A banquet will be served to the guests in the early evening at Independence Hall.

Following the banquet, the group will go to the Menlo Park laboratory, where the climax of the celebration will occur. There, in company with distinguished men who were with him in his original laboratory and the other guests, Mr. Edison is expected to reconstruct the lamp of half a century ago and make an electrical connection to cause it to light. A radio description of this event will be broadcast to what will doubtless be an enormous invisible audience.

The opening night of the national convention of the American Legion, to be held in Louisville, Ky., September 30 to October 3, will be dedicated to Edison and "Light's Golden Jubilee." Plans are to make it one of the most brilliant and colorful conventions ever held. More than one hundred thousand visitors, representing every state in the Union and twelve foreign countries, are expected to attend. Thirty-nine blocks of the business district of Louisville will be decorated, and special golden lamps will light the district.

Further particulars of the program arranged at Pittsburgh say that it will include such features as "paths of gold" along the principal thoroughfares, powerful searchlights sweeping the sky, through which blimps and airplanes will glide; floodlights, cluster illumination and other decorative effects for the principal buildings in the city and on all the river bridges; a night parade of between 250 and 500 motor-driven floats brilliantly lighted, and a spectacularly illuminated "pageant of progress" at Forbes Field, in which 3,500 persons will participate.

Plans for co-operation of Indianapolis citizens in celebrating the jubilee from October 18 to 21 are under way on a large scale. The Electric League of Indianapolis will have charge of the festival.

Einstein's Tribute to Edison

Albert Einstein, the famous exponent of relativity, in a letter from Germany to Edward L. Bernays, pays the following tribute (translated) to Thomas A. Edison on the occasion of "Light's Golden Jubilee," directly addressing the inventor in the second paragraph:

"The future writer of history will ascribe a high significance to our time because of the far-reaching changes of the conditions of life of humans which have carried them along on the path of a tremendous technical development. The human and animal muscle was relieved by the machine; the surface of the planet was melted down into economic entity through the completion of means of travel and transportation as well as of communication. Through this our time has created the prerequisites for a political union of mankind, which development, however, can only progress slowly owing to the backwardness of human traditions and valuations.

"Among the heroes of this world-historical process, you, honored Herr Edison, occupy a prominent rôle through having contributed a large share to make electric power serviceable to mankind. As one whose life has been made precious by his work, accept gladly this expression of thanks and heartfelt admiration."

Ford No Longer Interested In Muscle Shoals

In answer to an inquiry from Senator Heflin of Alabama, who sought to reinterest Henry Ford in Muscle Shoals, the automobile manufacturer instructed his secretary "to advise you that we have no plans at this time where the power at Muscle Shoals could be utilized and that it would be beyond the question for Mr. Ford to again make an offer. He has also suggested that in his opinion other interests are in a better position to develop and utilize the power."

Lackawanna Orders Equipment for Electrification

Equipment for the substations through which the Delaware, Lackawanna & Western Railroad will operate its coming electrified mileage between Hoboken and Montclair, Gladstone and Dover is to be made by the General Electric Company. There will be five substations. Two, at Bergen Junction and Newark, will receive electricity from the Public Service Gas & Electric Company; one, at Summit, from the Jersey Central Power & Light Company, and two, at Bernardsville and Denville, from the New Jersey Power & Light.

The equipment will include thirteen rectifiers and an equal number of transformer banks. The current supplied will be alternating at voltages ranging from 13,000 to 66,000 and will be converted to 3,000 volts direct current.

New York Ranks Second in Farms Served

President of Empire State Association Points to This in Refutation of Governor's Statements—Delegates to Convention Enjoy Addresses by Industry Leaders and Others

AMPLE refutation of some of the statements recently made by Governor Franklin D. Roosevelt of New York regarding the alleged neglect of the farmers of that state by the electric utilities was included in the address of President C. S. Ruffner at the annual convention of the Empire State Gas and Electric Association, held at Upper Saranac, N. Y., on September 19 and 20. "This branch of our business," said Mr. Ruffner, "which holds such tremendous possibilities in load building, has shown very substantial progress in the last three years. New York State now ranks second only to California in the number of farms served with electricity."

In order to meet the problems involved in further extending service, Mr. Ruffner pointed out the necessity of developing more aggressive sales efforts and of reconstructing and modernizing rate structures. "In this matter of rates," contended the president, "the public has certain rights. It is entitled to rates that it can understand. This means the simplification of rate structures and the elimination of that vast growth of schedules that has evolved either out of constantly changing conditions in the industry or out of an attempt to patch up some purely local situation with a new rate."

Matthew S. Sloan, president of the National Electric Light Association, also addressed the convention on Thursday. Mr. Sloan said: "There lies before us another opportunity for service. As we have been a basic element in revolutionizing conditions in American industry, so we must take equal part in revolutionizing American homes. We of the power and light companies have neither taken full advantage of our opportunities as business men nor done our full duty as agencies of public service."

Other speakers on the first day's program were Dean W. E. Mosher of the School of Citizenship and Public Affairs, Syracuse University; Earl Whitehorne, assistant vice-president McGraw-Hill Publishing Company, and Albert W. Whitney, president National Bureau of Casualty and Surety Underwriters. Dean Mosher viewed the electric utilities as needing a more positive and constructive leadership. As a first step he advocated the establishment of an industry code of ethics for both operating and holding companies. Mr. Whitehorne foresaw the need in the utility business of a closer approach to the attitude of other businesses which advertise and sell, not their factories or gifts to humanity, but their products, in terms of the user's interest. Mr. Whitney, whose topic was "Accident Prevention from an Executive Point of View," compared the old ideas of safety to an appliqué affixed after the engineers and architects had done their jobs, while the newer attitude makes safety a production factor.

In discussing the water-power development of New York State at the Friday session, R. J. Le Boeuf, Jr., cited decisions of the courts in past years and analyzed present political and legal elements, concluding that in New York there is little likelihood of state water-power development and that private enterprise should push ahead. Navigation he regarded as a secondary issue, from the standpoint of public welfare, power development being the important thing.

Other speakers on Friday included Senator Seabury C. Mastick, who advocated a state department of commerce; Oscar H. Fogg, president American Gas Association, and Frieda Miller, director Bureau of Women in Industry, who urged better appreciation of the woman's viewpoint as a consumer of manufactured products and as a worker in industry.

Reports of the year's activities were made by the chairmen of the accident prevention, accounting, electric meter, public utility information, public speaking, women's, electric, commercial and gas sections.

Officers elected for the coming year are: President, William J. Welch, president New York & Richmond Gas Company; first vice-president, John N. Carlisle, president Northern New York Utilities, Watertown; second vice-president, F. W. Smith, vice-president United Electric Light & Power Company, New York; treasurer, H. O. Palmer, vice-president Empire Gas & Electric Company, Geneva.

Georgia Power to Start Work on Oconee River Dam

Plans for the immediate construction of a hydro-electric power plant on the Oconee River, 4 miles north of Milledgeville, Ga., have been announced by Preston S. Arkwright, president of the Georgia Power Company. The project, which when it is completed will be one of the largest of its sort in the state, involves the construction of a dam 90 ft. high and with its abutments 3,000 ft. long across the Oconee River at Furman Shoals. A lake of 12,000 acres will be formed, the largest in Georgia.

The plant will be equipped with two 30,000-hp. generators, which will feed into the existing network of 110,000-volt and 44,000-volt transmission lines in the Macon and Augusta divisions of the company. Its capacity will be exceeded in Georgia only by the Tallulah Falls and Tugalo developments. Among the cities which will be particularly benefited are Milledgeville, Eatonton, Sparta, Macon, Augusta, Dublin, Wrightsville, Vidalia, Swainsboro and Statesboro. In addition to these communities, all served by the South Georgia Power Company will profit. Work will be started next month, and it is thought that the plant will be completed in the summer of 1931.

Regulation Broken Down, Roosevelt Says

Governor of New York Holds that State Commissions No Longer Serve the Public Because of Companies' Watered Stock and Overcapitalization

"I AM fully convinced that the public should handle the production of hydro-electric power and possibly its transmission, but that distribution may well be put in the hands of private enterprise under contract to insure the lowest possible rates to consumers."

Reiterating his views on water power in these words, Governor Roosevelt of New York, interviewed by a New York *Times* correspondent at Warm Springs, Ga., this week, went on to assert that "consumers in the Province of Ontario get their electric current for one-third to one-half the price paid by consumers on the American side of the border, although the Niagara River at Niagara Falls is the source of hydro-electric power on both sides."

The Governor then turned to the operation of public service commissions and the general policy of regulation of privately owned public utilities, on which, in apparent forgetfulness that, under the theory and practice of such regulation, valuation for rate-making purposes has nothing to do with capitalization, he said:

Under the original theory a public service corporation desiring to operate in a given territory would go to the Public Service Commission and ask for approval of the project, the idea being that the commission would protect the company from "wildcat" competition and guarantee a reasonable return on the invested capital by allowing such rates as would net such a return. That was perfectly right and proper, for the company in turn agreed to give the consumers in its territory the benefit of such economies and improvements as might be brought about in the service, by reducing rates accordingly.

What has happened, however, generally speaking, is that the capitalization of the big public utility enterprises does not by any means represent the actual money invested in the properties. As a matter of fact, the actual money investment is a comparatively small part of the capitalization. Nevertheless, the corporations still claim the right to receive a reasonable return on their total capitalizations, which include in almost every instance great quantities of watered stock representing no actual cash investment.

This condition of overcapitalization by the issuance of watered stock has come about under the regulation of public utilities by public service commissions, so that the policy has failed to maintain that degree of protection for the public which was contemplated at the outset. It appears to me that the policy of public service commission regulation has broken down and proved itself ineffectual for the purposes originally intended.

Purchases and Mergers

Portland Electric Power Company to Go to Public Utility Holding Corporation, Controlled by Harris-Forbes—Many Lesser Happenings

FROM its Portland (Ore.) correspondent the ELECTRICAL WORLD learns that Franklin T. Griffith, president Portland Electric Power Company, has confirmed without comment the announcement made in New York as coming from F. S. Burroughs, president of the Public Utility Holding Corporation of America—newly organized in New York City by the Harris-Forbes banking interests and associates—of an agreement between that corporation and the E. W. Clark interests of Philadelphia by which the latter's holdings in the Portland company will pass to the Public Utility Holding Corporation. This means that Harris-Forbes will control this important Pacific Coast company and lends plausibility to the stories that these bankers are planning to build up another great holding company controlling major plants in the West and elsewhere. Mr. Burroughs is familiar with the Portland property, having once been engineer for the Washington Public Service Commission.

The Portland Electric Power Company controls other operating companies at Aurora, Salem and Newberg, Ore., and serves a score or more of cities in addition to Portland. Its lines also connect with those of other large companies in Oregon, Washington and California. Last year it formulated a plan to purchase the physical properties of the Northwestern Electric Company, its local competitor, and on April 9, 1928, the voters of Portland were asked to sanction it. Despite a promise of lower rates, however, the citizens turned the proposal down by a ratio of more than two to one in a vote embracing only 50 per cent of the qualified voters.

Opposition continues in Pennsylvania to the merger of the Harmony Electric Company and the People's Power Company with the Pennsylvania Power Company, Youngstown, Ohio, and the Public Service Commission has directed the purchasing company to furnish appraisals of the properties. Manufacturers in the territories served allege that prices far in excess of fair values have been paid, reaching in some instances, according to William A. Magee of Pittsburgh, counsel for consumers, four times what should have been paid. Hearing was adjourned until October 9 to permit the Pennsylvania Power Company to get ready its answer.

Public hearings on the proposed seventy-million-dollar Indiana utility merger, affecting gas, interurban and power companies of the state, will be opened December 2 by the Public Service Commission. The proposed merger would affect utilities operating in approximately 284 cities and towns. The utilities involved, nearly all of which supply electrical energy, are the Central Indiana Power Company, Indiana Gas Light Company of Noblesville, Indiana Electric Corporation, Terre Haute, Indianapolis & Eastern Traction Company, Terre Haute Traction & Light Company, Northern Indiana Power Company, Wabash Valley Electric Company, Noblesville Water & Light Company, Colfax Electric Company, Moran Electric Light & Power Company, Mulberry Light & Power Company, Zionsville Water & Electric Light Company, Stilesville Electric Company, West Lebanon Electric Light, Heat & Power Company, West Indiana Utilities Company and the Brazil Electric Company.

Members of the Painesville (Ohio) City Council having declared their belief that the municipal light plant is worth more than $1,500,000, a citizens' committee which had circulated petitions for an initiative ordinance providing for the sale of the plant for not less than $900,000 has abandoned its efforts. The Cleveland Electric Illuminating Company had signified its willingness to bid on the basis last named, and petitions had been signed by more than a thousand voters, about seven times the required number.

The Inland Power & Light Corporation of Chicago, now controlling the Missouri Public Service Company and the Arkansas-Missouri Power Company, has asked the Missouri Public Service Commission for authority to acquire an interest greater than 10 per cent in the Missouri Edison Company of Louisiana, Mo., which operates light and power plants and distribution systems in eleven north Missouri towns. The Inland company would buy 2,400 shares of the Edison company's common stock for $187.34 a share. Towns served by the Missouri Edison Company are Annada, Ashley, Bowling Green, Clarksville, Curryville, Elsberry, Eolia, Louisiana, Paynesville, Silex and Whiteville.

A vote on the question of selling the municipal electric plant at Oakley, Kan., to the Central Power Company for $125,000 resulted in 223 for and 105 against, yet the sale was defeated because a law passed by the last Legislature requires that 51 per cent of registered voters confirm such sales. This made 267 votes necessary.

Higginsville, Mo., has refused to entertain an offer of $235,000 for its municipal light and water plant made by an independent broker who had expected to interest the Kansas City Power & Light Company in the plant had his overture been successful.

The Knightly Light & Power Company's plant on Middle River, between Fort Defiance and New Hope, Va., has been sold to unnamed Chicago interests for $95,000 cash, power lines and all equipment included. The plant serves New Hope, Fort Defiance, Harrison, Vernoa, Piedmont and Mowry Mill.

The Yuba River Power Company has been authorized by the California Railroad Commission to sell to the Pacific Gas & Electric Company its Bullard's Bar electric properties, including dam, power house and a transmission line, for $150,000 in cash, the purchaser to assume also outstanding bonds of the Yuba company amounting to $1,029,000. The properties are now operated under lease by the Pacific Gas & Electric.

Possibility of the Ontario Hydro-Electric Power Commission purchasing from the Foshay interests their three hydro-electric plants in Bruce County is seen in the presence in Toronto recently of W. B. Foshay and a corps of experts and accountants to confer with the commission. It is understood that an appraisal has been made of the Walkerton, Southampton and Wiarton plants and that terms of purchase have been discussed. Officials of the commission have on different occasions expressed the desirability of obtaining these plants.

The Northern British Columbia Power Corporation has purchased the Diesel-engine plant of the Dunwell Mining Company at Stewart, on the international boundary of Alaska and British Columbia.

Electrochemists' Part in Aviation Discussed

New Materials of Greater Strength and Lighter Weight Are Sought—Developments in Electric Heating Presented Ably at Pittsburgh Meeting

AT THE opening session of the fifty-sixth annual meeting of the American Electrochemical Society, held in Pittsburgh September 19, 20 and 21, developments in aviation were discussed from the point of view of better and more permanent materials.

Edward P. Warner said that the use of wood was decreasing, but that about 96 per cent of the five thousand planes in the United States used wood for wing struction even though about 3,500 tons of aluminum alloy could be used in the year's construction. He pointed out that production could follow only after cost reductions and stressed the necessity of lighter and stronger materials. Each pound saved could be capitalized at from $20 to $40, in the opinion of the speaker.

Dr. George Lewis pointed out that corrosion was a big handicap to the use of metal, especially where salt spray was encountered. W. G. Harvey showed magnesium alloy materials used in aircraft work that indicated a third saving in weight over aluminum alloy and said this material could be cast, extruded or forged. It consists of 92 per cent magnesium, 7 per cent aluminum and a small percentage of manganese.

Several methods for putting a noncorrosive coating on aluminum were suggested. Dr. H. W. Gillett thought that the great strength, light weight and other desirable characteristics of beryllium might make it desirable for aircraft, but he stated the necessity for further research on this product.

W. P. Dobson and A. S. L. Barnes suggested a use for great amounts of electric power in making oxygen and hydrogen gas. It was pointed out that the arc process of nitrogen fixation was being displaced in favor of the synthetic ammonia process. In Norway alone 120,000 kw. of hydro power formerly used in nitrogen fixation is now used to produce oxygen and hydrogen. The Consolidated Mining Company of British Columbia is now to use 17,000 kw. for this purpose. Several other contemplated installations were noted. The commercial demand for hydrogen is great, and no doubt was felt that means will be found to use the oxygen.

Farley G. Clark advocated the employment of the secondary power from Muscle Shoals to make hydrogen gas for use in a synthetic ammonia plant. To compete with other plants the primary power would have to be available at $25 a kilowatt, but with the use of secondary power he estimated that ammonia could be delivered for $59.23 per ton, assuring government costs for capital.

A symposium on electric furnaces for melting and treating non-ferrous metals brought out the fact that the electric furnace of the induction type is gaining greatly in favor for brass melting and

can be used for alloy steel melting to good advantage. There still exists a dispute as to the relative advantages of the arc and induction types for finishing operations. The arc gives a reducing action continuously, while reducing agents must be added to induction-furnace charges.

Robert W. Keeney asserted that there is about 15,000 kw. in furnace installation in this country for non-ferrous operation and that 3,000 kw. has been added this year. The big field, he said, is in annealing work and in malleable applications. The gas industry is very aggressive in this field and the electric furnace has stiff competition. Improved designs and the use of gas atmospheres, however, indicate a large use of electric furnaces in the future. A major goal in annealing is to get a bright anneal without the necessity for pickling.

The use of nitrogen gas, Mr. Keeney went on, has aided this operation when copper is used, but much remains to be done to get an entirely satisfactory process. In nickel-silver annealing good results have been had with gas-fired furnaces with gas as part of the atmosphere, and water-seal electric furnaces find competition difficult. The electric furnace, however, is gaining overwhelming favor for melting the nickel-silver alloys. In the aluminum alloy field about 3,000 kw. in furnaces is used and the gains are rapid. In the entire non-ferrous industry annealing is the big problem, the speaker asserted, and advocates of electric heat have far to go to answer the problem economically.

In the opinion of Mr. Keenan, a recent elevator type of electric furnace gives evidence of a splendid field for electric heat in the malleable industry. The time for the cycle was 30 hours as compared with 130 to 150 hours by the old process. It was also reported that the "Globar" type of furnace had proved very successful for forging furnaces, giving a temperature of 2,500 deg. with an average element life of 1,000 hours. The use of convection instead of direct radiation in electric annealing furnaces was reported as giving very satisfactory results in that it produced a uniform temperature.

Many other technical papers of interest were presented, and there were visits to Pittsburgh industries, a smoker and a banquet. About 500 were in attendance.

New Interconnections Between Kentucky Companies

Surveys are well under way for three high-tension power lines aggregating 114 miles to link the electric transmission systems of the Kentucky Utilities Company and the Kentucky Power & Light Company, at an estimated cost of $507,000. Construction will start October 1 on a 66,000-volt line from Lexington to Maysville, a distance of 60 miles, with substations at Millersburg and Maysville. Another 66,000-volt line will extend 33 miles from Shelbyville to Carrollton, with a 66,000-volt switching station at Shelbyville and a substation at Carrollton. A 33,000-volt line will run for 21 miles from Mount Sterling to Salt Lick near Morehead, and the capacity of the Morehead-Salt Lick line will be raised to that voltage. The work will be completed early next spring. The interconnections will increase from 5,000 hp. to more than 25,000 hp. the potential power supply of the Kentucky Power & Light Company, which serves 48 communities in northeastern Kentucky, and will combine the energy output of the two companies in central, northeastern and southeastern sections of the state.

The Kentucky Power & Light Company, with headquarters at Maysville, is a subsidiary of United Public Service Company, which was bought August 7 last by the Middle West Utilities Company, of which the Kentucky Utilities Company, serving 230 communities, is a subsidiary.

Nebraska's Sales Conference Inspires Emulation

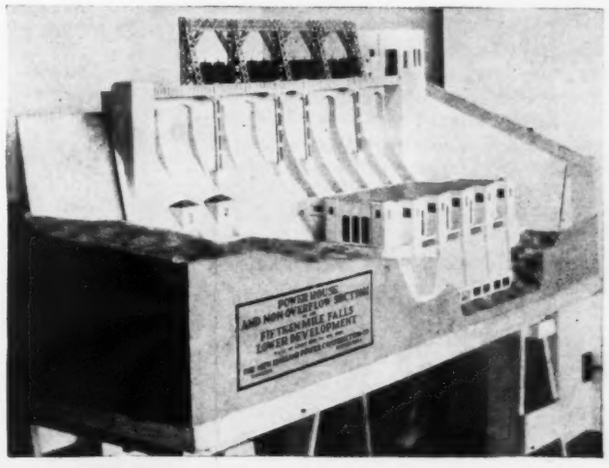
The Nebraska Section of the N.E.L.A. recently concluded its fifth annual three-day commercial school, at which only sales managers, high-grade salesmen and representatives of jobbers and manufacturers are eligible for registration. The fame of this sales congress has spread until nationally it holds second place only to the Association Island meeting and so is able to command the attendance as instructors of some of the best-known sales managers in the industry. At the recent meeting men of this type discussed the problems and phases of salesmanship. At the conclusion of each address the chairman of the day summarized what had been said and led the discussion. Some of the addresses were educational with respect to the products handled, such as electric refrigerators, and contained information as to latest developments in invention.

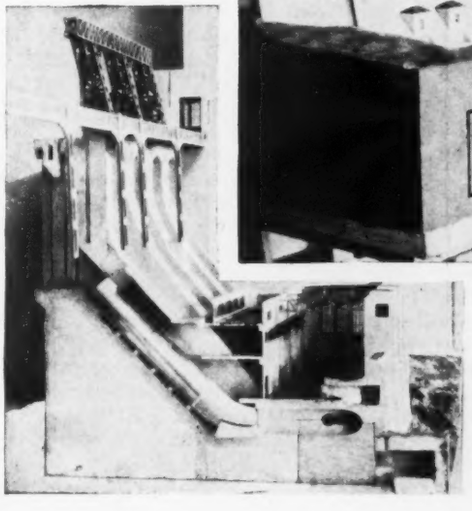
When the school was first started between 25 and 30 attended. At the session just closed 116 were registered and 90 per cent were in regular attendance. The school is held at a permanent camp in the woods near Crete, 20 miles from Lincoln, remote from any distractions. Ten sleeping tents, an "administration building" and a dining hall make up the camp. Quasi-military routine prevails, though there is plenty of time for relaxation and enjoyment. The commercial committee of the Nebraska Section is sponsor for the school, developing the programs and getting the speakers. The fee, ranging from $10 to $14, includes meals and lodging.

The officers of the Middle West Division of the N.E.L.A. have recommended to the associations in Iowa, Kansas and Missouri that similar sales congresses be regularly held in each of those states in the future, Nebraska having blazed the way.

Construction Model of Fifteen-Mile Falls Plant

IN CONNECTION with the construction of the Fifteen-Mile Falls hydro-electric development of the New England Power Association the engineering department at Boston recently built a model of the non-overflow section of the dam and the generating station to a scale of 8 ft. per inch and having over-all dimensions of about 7 ft. x 4.3 ft. x 3 ft. Four 50,000-hp. turbines will drive four 39,000-kva. generators in the lower of two developments to be made on the Connecticut River in upper New Hampshire and Vermont. The design of the dam and generating station is shown in one view with the building complete, and by opening the model at a central joint the penstock and power house interior design are revealed.





System Stability to Be Theme of Great Lakes Engineers

Power system stability, the theme set for the general open meeting of the Engineering Section, Great Lakes Division, N.E.L.A., at Madison, Wis., on the morning of Thursday, October 24, will be discussed by five prominent electrical engineers as follows:

"The General Stability Situation," Alex D. Bailey, chairman Engineering National Section.

"Power System Stability as Affected by Hydraulic Plant Design," Forrest Nagler, hydraulic engineer Allis-Chalmers Manufacturing Company.

"Power System Stability as Affected by Steam-Plant and Substation Design," Robert Treat, central-station engineering department, General Electric Company.

"Power System Stability as Affected by Transmission System Design," C. L. Fortescue, consulting transmission engineering Westinghouse Electric & Manufacturing Company.

"Power System Stability as Affected by General System Characteristics," J. H. Foote, electrical engineer Stevens & Wood, Inc.

Committee meetings and inspection trips will fill the rest of the time, with a banquet on Thursday evening.

Height of Boulder Dam May Be Increased by 25 Feet

Secretary of the Interior Wilbur announced this week that the Reclamation Bureau has been instructed to study plans of Boulder Dam with a view to carrying it 25 ft. higher than was first planned. Commissioner Mead of the Reclamation Service has been instructed to give careful consideration to the factors of safety, power, additional flood control and the possibility of prolonging the life of the project if the structure reaches the additional height.

If the dam is built 25 ft. higher, it will be 725 ft. from the bottom of the foundation to the top and 550 ft. above the present water level of the Colorado River. For each additional foot on the height of the dam there would be made available a minimum increase of 150,000 acre-feet of storage space and a decided gain in power capacity. Mr. Mead expressed his belief that the proposal is feasible and practical. Revenue returns from the additional potential power, it is expected, will take ample care of the increased cost of construction.

Demonstration of "Osiso" in New York

A demonstration of "osiso," the instrument lately developed by the Westinghouse Electric & Manufacturing Company on oscillographic principles, was made in New York City last week by that company in co-operation with the American Steel & Wire Company. By this device vibrations, such as sound, are converted into electrical impulses for operating the oscillographic element, and the beam of light reflected by the oscillograph mirror is spread out on a stationary screen by another mirror with sixteen sides which revolves rapidly. This permits the wave form to be studied in detail.

It was employed in New York to analyze musical tones, an ordinary microphone being placed near the sounding board of a grand piano. When a note was struck the sound picked up by the microphone was amplified, and the resulting current was made to operate on an element of the osiso. This, however, is merely one out of a multitude of possible uses for the Westinghouse instrument, which is applicable to the analysis of any vibrations which can be transformed into waves. The device may be applied to the study of objects ranging from the steel wire used in bridge construction to steel rails.

Ten Thousand Missouri Farms Now Have Electricity

Statistics compiled by the Missouri Committee on Public Utility Information indicate that 10,285 Missouri farms are now purchasing electricity from privately operated and municipal power plants. The survey indicates that 4.7 per cent of all Missouri farms are now using electricity, 1,592 miles of wire being employed in serving them. In 1924 a similar check showed only 2,207 rural customers of electric power plants, and in 1926 the total had been increased to 3,812.

Of the buyers, 9,208 are served by 22 large companies, 1,020 by 46 municipal plants, and 57 by 11 small power plants. The largest number are in the vicinity of the larger cities such as St. Louis, Kansas City, Springfield and St. Joseph.

Refrigeration on the Farm in South Dakota

The ice house on the farm, as well as the ice box, soon will be replaced by electric refrigeration if results of recent investigations by the State College at Brookings, S. D., are accurate indications of cooling methods to be employed on the farm of the future. The research work on electric refrigeration was conducted on seventeen farms served by the electric test line near Renner, under the supervision of Ralph L. Patty, head of the department of agricultural engineering.

As summarized in a State College experiment bulletin, the results show that four home electric refrigerators used an average of 378 kw.-hr. of electricity for one year, which at 3 cents a kilowatt-hour cost each owner $11.91. In the three warmest summer months each of eight refrigerators averaged 77 kw.-hr. of electricity a month, at a cost of $2.31. At the 3-cent rate it cost the Renner line patron $6.57 to run his refrigerator all winter, the report showed.

It was pointed out that the average temperature maintained by home electric refrigerators is 42.46 deg. F., or approximately ten degrees lower than the temperature maintained in ice boxes tested. On the whole, Professor Patty says, the cost figures on the operation of the electric refrigerator compare favorably with the cost of building an ice house and putting up ice.

Briefer News

PIQUA, OHIO, ALSO DALLIES WITH IDEA OF CITY PLANT.—Citizens of Piqua, Ohio, are circulating petitions for the erection of municipally owned power, light and gas plants, prompted, it is declared, by an announcement of the Dayton Power & Light Company that it will seek a material increase in the price of gas.

PUGET SOUND POWER & LIGHT FINISHING NEW TRANSMISSION LINE.—The high-tension transmission line being erected by the Puget Sound Power & Light Company from the Shuffleton plant at Renton, Wash., to Beverly Park substation will, it is expected, be put in operation during October. The line, which will be 32 miles long and supply 26,000 kw., will cost about $400,000.

TWO-PART DOMESTIC RATE FOR SEDALIA, MO.—The City Light & Traction Company of Sedalia, Mo., has applied to the Missouri Public Service Commission for authority to file new electric rates covering residence service. The schedule, which will cover all domestic services including lighting, cooking, heating, refrigeration and power, is built in two parts, one a reservation or delivery charge, followed by a meter rate schedule of several low steps.

ANOTHER STEP IN HIGHWAY LIGHTING IN NEW YORK STATE.—Plans to light a new and heavily traveled road between Hornell and Canisteo, N. Y., are under consideration by the New York Central Electric Corporation, which will first install lighting units over half the distance as a trial of the value of such highway lighting and then, if satisfied, will probably extend the system and cover other roads in Steuben County. Hornell and Canisteo are about 12 miles apart.

LINN CREEK "DIEHARDS" MAKE NEW MOVE.—The village of Linn Creek, county seat for Camden County, Mo., and 61 taxpayers have carried the fight to preserve that village into the courts by asking for an injunction to prevent the construction of the Union Electric Light & Power Company's great hydro-electric dam and power plant at Bagnell on the Osage River. The project is alleged to be unconstitu-

tional and the contract with Camden County irregular. President Louis H. Egan of the Union Electric Light & Power Company says that his company is not trying to dodge any of its obligations and will pay all damages.

PARIS, TENN., MUST PAY $82,000 FOR COMPANY EXPENDITURES IN RECAPTURED CITY PLANT.—Approximately $82,000 has been allowed the Kentucky-Tennessee Light & Power Company by a federal court for improvements it made in the power plant at Paris, Tenn., while that plant, recently recaptured by the city, was under lease to the utility. Much litigation has surrounded the transfer and retransfer of the Paris plant. (See ELECTRICAL WORLD for February 9, page 313.)

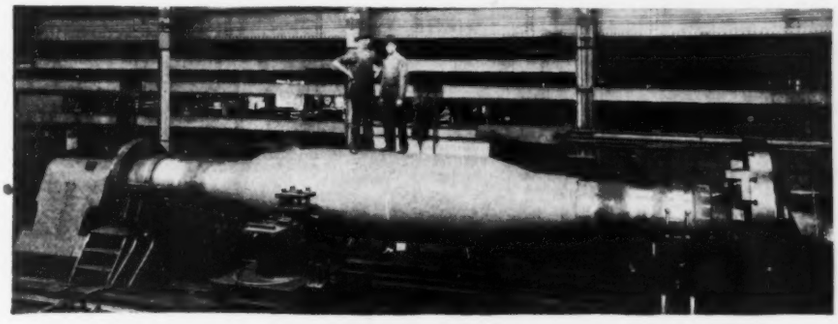
ROCHESTER, MINN., TALKS OF GENERATING PLANT ON THE ZUMBRO.—Whether Rochester, Minn., can derive sufficient power for municipal purposes from development of the Zumbro River at Oronoco will be determined in a survey which has been authorized by the City Council. Water power has been developed there for many years, chiefly for the operation of mills. If development is decided upon after the survey, electricity will be transmitted to Rochester for use there. L. A. Cowles, superintendent of the municipal electric plant, believes the Oronoco site has great potentialities.

UTICA RATE CASE ENDS.—The Utica (N. Y.) Common Council voted on September 18 to discontinue the city's action before the Public Service Commission against the Utica Gas & Electric Company for lower rates and to accept the proposed reduction offered by the company and recommended for acceptance by Dr. Edward W. Bemis, the city's expert. This probably ends the long-drawn-out controversy noted from time to time in these columns. The company has filed with the Public Service Commission rates which will produce an annual saving of nearly $247,000, which is almost $30,000 greater than the saving promised. Residential customers in Utica will save about $98,100 and commercial small-power customers about $110,800. The remainder of the aggregate saving will be distributed throughout the company's territory by application of the new commercial schedule, the lower rate for residential service and elimination of the delayed-payment charge.

RAINS HELP WATER POWER IN NEW YORK.—The power situation at the hydro-electric plants of the New York Power & Light Corporation has been greatly improved as a result of rains, according to Otto Snyder, executive vice-president of the company. This rainfall amounted to between four and five inches taken over the entire Hudson and Mohawk River watersheds, and the system storage is now 55 per cent full as compared with 48 per cent two or three weeks ago. Steam stations are still generating at the rate of 60,000 kw. to supply firm power and permit closing down the hydro stations at night to build up pondage.

LINCOLN MAY ENLARGE MUNICIPAL POWER HOUSE.—The water and light board of Lincoln, Neb., has tentatively approved an appropriation aggregating $500,000 out of the net proceeds of the municipal lighting and water departments for the next five years for additions and betterments, a third to the former and the remainder to the latter department. The plans include installation of a turbine and other equipment at the main lighting station.

LARGE GENERATOR SHAFT MANUFACTURED BY WESTINGHOUSE.—One of the largest shafts ever built was recently machined in the shops of the Westinghouse Electric & Manufacturing Company at East Pittsburgh, Pa. This shaft weighs approximately 140,000 lb. and has a maximum finished diameter of 53 in. with an overall length of 32 ft. It was forged by the Midvale Steel Company from an octagonal ingot approximately 82 in. in diameter and weighing 290,000 lb. It is designed to be supported with the rotor on two large bearings, 30 in. in diameter by 60 in. long. The shaft will be used in the rotating part of a 60,000-kva., 514-r.p.m. horizontal generator for use in the test laboratory of the Westinghouse Electric & Manufacturing Company.



CAMPBELL RIVER SITE GOES TO BRITISH COLUMBIA POWER CORPORATION.—Development of the Campbell River power project, the largest enterprise of its kind on Vancouver Island, will be proceeded with under the guidance of the British Columbia Power Corporation, to which the necessary certificate has been granted by the government. The company has until February 28, 1931, to file the plans for the development, over which much rivalry has been exhibited. The new project may become the nucleus of a new chain of power plants in western Canada.

NEW 75,000-KW. UNIT AT CAHOKIA PLANT.—With the readiness for service of the new 75,000-kw. single-cylinder General Electric turbo-generator at the Cahokia plant of the Union Electric Light & Power Company of St. Louis, the culmination of an eighteen months' construction program is reached. The unit is 50 per cent larger than any heretofore installed by that company. It replaces a 35,000-kw. generator less than six years old, which has been removed and set up in the company's station at Venice, Ill., a 1,950-hp. boiler being installed there to serve it. The big new machine at Cahokia occupies virtually the same space as its predecessor and will take 4.7 per cent less steam.

FOREST FIRES ENDANGER OREGON TRANSMISSION LINES. — With forest fires constantly endangering transmission lines and the extreme shortage of water greatly interfering with operations in various parts of the state, some Oregon electric utilities are being forced to carry on under rather trying conditions. In the southern and central districts of the state the California-Oregon Power Company, with the aid of the State Forestry Department, is keeping its power lines up and overcoming difficulty. The Gold Beach Electric Company and the Mountain States Power Company, operating in the southwestern section, are faced with the same condition, while lines of the Pacific Light & Power Company in the Hood River National Forest area are undergoing more or less danger.

WISCONSIN UTILITIES WOMEN HOLD TWO-DAY CONFERENCE.—Employees of light and power companies were well represented among the fifteen or more women who took part in a two-day conference at Milwaukee on September 19 and 20 under the auspices of the Wisconsin Utilities Association, Ruth C. Tarum of the Northern States Power Company being chairman. Utility officials made addresses, which were followed by discussions, and there were four-minute talks on opportunities to serve the public.

"HOWARD" SUBSTATION OF OHIO POWER COMPANY NEARS COMPLETION.—At Shelby, Ohio, a 50,000-kw. substation is rapidly nearing completion for the Ohio Power Company. This substation, known as the "Howard," is connected with the recently expanded Philo station of the company by a 132-kv. line completed a few weeks ago. From Shelby this line extends to Fostoria, 125 miles distant from Philo. It is also connected through the Ohio Public Service Company's lines with the Sun-

nyside station at Canton. The new line, which is a single-circuit one, is likely to be changed to double-circuit transmission in the near future, having been designed with that end in view.

MERGER OF ROCKY MOUNTAIN STATE UTILITY ASSOCIATIONS IS URGED.—Consensus of opinion as brought out at the recent Glenwood Springs sessions of the utility associations of Colorado and Wyoming indicates that a merger of the Colorado, New Mexico and Wyoming utility associations into a combined Rocky Mountain association is imminent. Such a move has been afoot for several years, and a committee was formed at Glenwood Springs to determine its working possibilities.

IOWA CITIES INSTALL DIESEL-ENGINE PLANTS.—The Municipal Utilities Company of Des Moines, which installs electric generating plants for communities, taking the earnings until the profits amount to the initial cost and then turning over the plant to the city, has just completed a Diesel-engine plant at Clarion, Iowa, costing $160,000. It is the second plant to be completed in Iowa by this company, one at Emmetsburg having been in operation for nearly a year. Erection of a plant at Sumner, Iowa, will be started when the Clarion plant is put in operation.

LARGE STEAM-ELECTRIC PLANT MAY BE BUILT AT NIAGARA FALLS.—In addition to the 75,000-kw. turbo-generator to be added to the Charles R. Huntley station of the Buffalo General Electric Company, a plan to build a steam-electric plant of that size at Niagara Falls is under consideration by the Buffalo, Niagara & Eastern Power Corporation, according to a publication issued by the latter company. Increasing power demands from electrochemical industries and inability to divert further water from Niagara Falls may force this to be done, although the cost of the power thus derived would, it is stated, be almost double that of the hydro-electricity.

OPPOSITION FROM ALABAMA POWER CUSTOMERS TO RATES FAVORED BY COMMISSION'S ENGINEER.—A resolution opposing the rate recommendations of I. F. McDonnell, chief engineer of the Alabama Public Service Commission, was presented to the commission last week by a committee representing the Alabama League of Municipalities, which protested against any revision which would tend to increase the cost of power distributed to the municipalities. Another protest came from Mobile directed against Mr. McDonnell's proposed 20 per cent differential on direct current. The hearing was adjourned.

MANY RATE REDUCTIONS IN NEW YORK STATE.—Approval has been granted by the New York Public Service Commission to new rate schedules operating generally to effect reductions to customers in the territory of four important companies. New schedules of the Rochester Gas & Electric Corporation apply to six townships and various villages; of the New York Power & Light Corporation, to its Ballston, Glens Falls, Greenwich, Oneida and Saratoga districts; of the New York Central Electric Corporation, to Hammondsport, Penn Yan and seventeen towns, and of the Lake Ontario Power Corporation, to Sodus, Webster and five towns.

TERMS OF CONTRACT BETWEEN DAYTON POWER & LIGHT AND OHIO EDISON COMPANIES.—Accidental omission of a very essential term from the report printed in a recent issue of the ELECTRICAL WORLD concerning the contract for power to be transmitted over the transmission line to be built from Dayton to Springfield, Ohio, and purchased by the Ohio Edison Company from the Dayton Power & Light Company led to the quotation of a price obviously much too low. For the first three years of interconnection the Ohio Edison Company has agreed to purchase energy aggregating 32,000,000-kw.-hr. For this the Ohio Edison will pay a fixed charge of $55,000 yearly and in addition a kilowatt-hour charge of 6 mills for the first 500,000 kw.-hr. a month and 5 mills for all in excess of that amount. The kilowatt-hour charge was omitted from the previous item as printed.

Coming Meetings

[A complete directory of electrical associations, with their secretaries, is published in the first issue of every volume. For latest list see issue of July 6, page 46.]

American Electric Railway Association—Atlantic City, Sept. 30-Oct. 4. J. W. Welsh, 292 Madison Ave., New York.

Association of Electragists International—New Ocean House, Swampscott, Mass., Sept. 30-Oct. 3. L. W. Davis, 420 Lexington Ave., New York.

National Safety Council—Stevens Hotel, Chicago, Sept. 30-Oct. 4. W. H. Cameron, 108 East Ohio St., Chicago.

Wisconsin Utilities Association, Commercial Section—Retlaw Hotel, Fond du Lac, Oct. 3 and 4. John N. Cadby, 105 Wells St., Milwaukee.

National Electrical Manufacturers' Association—Wardman Park Hotel, Washington, Oct. 7-11. S. N. Clarkson, 420 Lexington Ave., New York.

American Society of Mechanical Engineers—National fuel meeting, Bellevue-Stratford Hotel, Philadelphia, Oct. 7-10. C. V. Rice, 29 West 39th St., New York.

International Association of Electrical Inspectors—Southern Section, Ansley Hotel, Atlanta, Oct. 15-17. R. L. Gatewood, P. O. Box 1743, Atlanta.

Kansas Section, N.E.L.A.—Hutchinson, Oct. 17-18. H. Lee Jones, Kansas Gas & Electric Co., Wichita, Kan.

Public Utilities Association of West Virginia—Charleston, W. Va., Oct. 23-24. A. Bliss McCrum, P. O. Box 1483, Charleston, W. Va.

Great Lakes Division, N.E.L.A.—Engineering Section, Lorain Hotel, Madison, Wis., Oct. 23-26. L. F. Hickernell, Stevens & Wood, Jackson, Mich.

American Engineering Council—Mayflower Hotel, Washington, Oct. 24-25. L. W. Wallace, 26 Jackson Place, Washington, D. C.

North Central Division, N.E.L.A.—Accounting Section, Nicollet Hotel, Minneapolis, Oct. 28 and 29. J. W. Lapham, 803 Plymouth Bldg., Minneapolis.

Public Utilities Association of Virginia—Chamberlin-Vanderbilt Hotel, Old Point, Va., Nov. 21 and 22. A. B. Tunis, 306 Grace Securities Bldg., Richmond, Va.

American Institute of Electrical Engineers—District meeting, Chicago, Dec. 2-4. F. L. Hutchinson, 33 West 39th St., New York.

MUNICIPAL PLANT AGITATION IN ARKANSAS.—The City Council of Russellville, Ark., has passed unanimously an ordinance providing for a bond issue of $200,000 to build a municipal light and power plant. It will probably be submitted to the voters in October. A similar movement is under way in Morrillton, Ark., where a special committee of the City Council has recommended a city plant. The Arkansas Power & Light Company is endeavoring to show both towns that their contemplated action would be a mistake.

TENNESSEE ELECTRIC POWER REDUCES RATES.—A voluntary reduction of from 10 to 20 per cent in electric rates in Cleveland, McMinnville, Lenoir City, Harriman, Maryville and about a hundred smaller places in middle and east Tennessee served by the Tennessee Electric Power Company was approved last week by the Railroad and Public Utilities Commission. It will be applicable to residence as well as business lighting. The new residential rate will be 10 cents per kilowatt-hour for the first 50 kw.-hr. a month, 7 cents for the next 50 kw.-hr. and 5 cents for all the excess.

DISPUTE OVER TAXATION OF DUKE POWER COMPANY ENDED.—After a prolonged dispute the Duke Power Company has paid $83,413 to the tax commissioner of North Carolina, representing 1 per cent of the gross receipts of the Southern Power Company for the eleven months that that company operated in 1927 before the Duke Power Company took it over. The commissioner admitted that the company had at least technical grounds on which to resist payment, and he has publicly commended the company's action in not taking the matter to the courts.

RURAL ELECTRIFICATION CONFERENCE AT PURDUE.—On October 10 to 12 a conference on rural electrification will be held at Purdue University, Lafayette, Ind., under the direction of the agricultural experiment station of the university in co-operation with the Indiana Electric Light Association. This will be the third annual conference so held. Among the participants from the agricultural department of the university will be Dean J. H. Skinner, T. A. Coleman, Profs. G. W. McCuen, J. H. Hilton, C. W. Carrick, Miriam Rapp, E. W. Lehmann, F. D. Brooks and E. H. Parfitt. Utility men taking part will include Eugene Halcomb, chairman rural service committee, N.E.L.A.; C. V. Sorensen, president Indiana Electric Light Association;

Arthur Huntington, Richard Boonstra and Douglas Dow. Arthur Shugart, Marion, Ind., will tell "How Electricity Pays Its Way on My Farm," and discussions on rural merchandising and on new and unusual uses of electricity on the farm will be held.

Paying for Equipment from Future Profits

Legality of Such Contracts Between a Municipality and a Manufacturing Company to Be Passed Upon by Nebraska Supreme Court

A CASE in which it is sought to upset a contract between the municipality of Sargent, Neb., and Fairbanks, Morse & Company by which equipment to be supplied by the latter to the city lighting plant would be paid for out of the future earnings of the plant will be heard by the Nebraska Supreme Court on October 7. The League of Nebraska Municipalities, which tried to get through the Legislature a bill making such contracts legal and, failing in this effort, has maintained that, in the absence of legislative prohibition, a city government has the implied power to make a contract of this nature (since it does not increase taxation or the city debt), will participate in the trial as a friend of the court.

Two recent judgments have been cited by Fairbanks, Morse & Company in their brief. One by the Iowa Supreme Court in Johnston vs. City of Stuart (226 N.W. 164) was abstracted on this page on September 7 (page 491). In the other, a Utah judgment (Barnes & Gurney vs. Lehi City and Fairbanks, Morse & Company, the Utah Light & Power Company appearing as a friend of the court), the court said:

Public policy favors the freedom of contract. However, the restrictions placed upon municipal corporations by the debt-limit provision of the constitution must be upheld. The purpose of such provisions is to serve as a limit to taxation and as a protection to taxpayers. It has now become a well-recognized principle of law that these constitutional provisions do not apply to a case where public property is purchased or constructed and payment therefor is to be made exclusively from the revenues derived from the property. In the instant case impounding the earnings of the electric light and power plant in a special fund which is expressly pledged for the purpose of maintaining the plant and the payment of the interest and purchase price installments as they accrue under the proposed contract cast no additional burden on the taxpayers. When, as here, a uniform rate must be charged for the product of the plant, the burden falls wholly upon the consumers, who pay in proportion to the benefits received by them. In making the purchase the consumers act entirely upon their own volition. They pay for a product furnished them at their own request and which is essential to their comfort and convenience. The credit of the city is not extended nor is any money derived from taxation or other existing sources of revenue expended in the purchase price or maintenance cost of the plant. We are of the opinion that by entering into the proposed contract with Fairbanks, Morse & Company, Lehi City will not thereby create such an indebtedness as is contemplated and prohibited by the state constitution.

Commission Rulings

CONDITIONS WARRANTING A MUNICIPAL PLANT TO EXTEND SERVICE BEYOND LOCAL BOUNDARIES.—Authority has been granted by the New York Public Service Commission to the village of Boonville to build and maintain electric light plants for other than municipal purposes in the towns of Leyden, Lewis, Ava, Lee and Western. The commission said: "The village of Boonville has owned and operated a municipal light system since 1903 within the village. At various time it has extended its distribution lines outside of the village. Extensions have all been paid for out of its earnings. There is no outstanding or funded indebtedness except an amount of less than $6,000. The rate to consumers outside of the village is higher than the village rates, and this business has been carried on without profit and no other electric company renders service in the territory the petitioner is now covering. The permission is granted for the purpose of public interest and for the purpose of legalizing the service now rendered."

COLORADO COMMISSION CONDEMNS IMPOSITION OF BURDENSOME PAYMENTS ON FRANCHISE HOLDERS.—In an ordinance granting a franchise to the Home Gas & Electric Company in Greeley, Colo., a tax of 1 per cent on gross earnings was imposed as a condition. This was in lieu of pole and wire license fees, and therefore the Public Utilities Commission refused to grant the company's request that it be set aside, saying that it must first be shown to be a burden to the company's customers. The commission, however, condemned strongly burdensome imposts as a condition of granting franchises, saying: "We see no difference in the principle between giving free service to a city and the payment of money to a city merely as a consideration for granting a franchise, because in the latter case the city obtains money to defray the municipal expenses which should come from all the taxpayers and not merely those who are customers of the utility. A municipality has been given by the Legislature certain powers respecting public utilities, including the power to grant franchise rights in the streets. These powers are to be exercised for the benefit of the citizens, the municipality acting as a sort of trustee. Since the customers of the utility in the end pay whatever consideration the city receives for issuing the franchise, the effect of the requirement of the payment of the consideration is to force the customers of the utility to pay the taxpayers in general for the privilege of securing service of the utility. We cannot see any justification for the requirement of such a payment."

PURPOSE OF MINIMUM CHARGE.—PEAK AND OFF-PEAK SERVICE.—MANAGERIAL DISCRETION.—Dismissing a complaint made by the Balaban & Katz Corporation, theater operators, against the Commonwealth Edison Company, the Illinois Commerce Commission made several observations on the points in dispute, as follows: (1) A minimum charge does not purport to represent in any way the actual worth or cost of service, but is merely a provision to enable some revenue to be obtained from a customer who uses less than his normal consumption, in order to cover some of the fixed charges upon the utility plant held in readiness for such service. (2) While a rate schedule designed to recognize more generally a distinction between off-peak demands and peak-period demands, making a lower rate for the former demands available to a larger group of consumers, might have merit, it does not follow that a rate failing to do so is necessarily discriminatory or illegal, nor does it follow that a rate is discriminatory because it sets a definite point or ratio of peak to off-peak demands, recognizing the distinction on one side of that point and not recognizing it on the other. (3) It is not practical to require that all rate schedules provide for the sale of electricity at a rate that accurately reflects the "unitary value" of that energy in all cases. (4) The exact point at which a ratio is to be fixed between off-peak-period demands and permissible peak-period demands, in order to limit a schedule to those who are, in practical operation, off-peak customers, is a matter which involves the exercise of managerial judgment and will not be disturbed by the commission unless the ratio fixed appears on the record to be unreasonable, unjust and discriminatory.

Recent Court Decisions

IRREVOCABLE RATES DISAPPROVED.—A contract between the city of Baton Rouge, La., and the Baton Rouge Waterworks Company was held void by the United States Circuit Court in Louisiana because the parties to it attempted to fix irrevocable rates by a consent decree and thus avoid the inhibition of the state constitution, which the federal court held forbade such rates and could not be circumvented. (30 Fed. [2d] 895.)*

COMMISSION MUST NOT PREDICATE RATES ON POSSIBLE FUTURE EXPANSION.—After fifteen months of hearings and litigation, a permanent injunction against the Montana Public Service Commission has been issued by the United States District Court—three judges sitting in special session and reaching a unanimous decision—forbidding the commission to impose upon the Great Falls Gas Company a schedule of rates for natural gas which it had ordered the company to adopt. The court said: "The commission did not determine rates which would provide a fair return, but rates which might do so several or three to five years in the future. To that end its forecast exceeded the plaintiff's 16 per cent in the number of patrons that might be had and 52 per cent in the amount of gas they might buy." The court in effect held that this evidence of a rate schedule based on possible future expansion was sufficient to overrule the order of the state commission. It also said that different conditions prevailed at Great Falls from those at Billings, the commission's proposed new rates having been made to conform generally to those in the latter city.

*The left-hand numbers refer to the volume and the right-hand numbers to the page of the National Reporter System.

News About Men of the Industry

WALTER C. LANG, for several years assistant controller of the Electric Bond & Share Company, has been elected controller of the company to succeed Albert E. Smith, who died September 1.

A. L. MARTIN has been appointed district manager of the western Wyoming properties of the Mountain States Power Company. This position places Mr. Martin in charge of eight communities with headquarters in the city of Thermopolis.

DAVID DARLINGTON, formerly assistant treasurer of the New York Edison Company, has joined the Jordan Advertising Abroad, Inc., specialists in the creation and direction of foreign advertising. Mr. Darlington has become a director and has been elected treasurer of the organization.

DR. A. C. SCOTT, president of the Scott and White hospital at Temple, has been elected a director of the Texas Power & Light Company. Dr. Scott is a nationally known surgeon and in addition has been interested in many civic and industrial developments in Texas.

JUDGE HARLAN G. PALMER, Hollywood, Calif., newspaper publisher, appointed by Mayor John C. Porter of Los Angeles to the Board of Water and Power Commissioners, was elected president of the board when it organized July 26 for the forthcoming year. He succeeds John R. Richards as president.

WALTER S. WYMAN, president of the New England Public Service Company and the Central Maine Power Company, Augusta, Me., has been elected president of the Union Power Company, Lewiston, Me. The Union company owns the canal system in Lewiston and Auburn and controls headwaters on the Androscoggin River.

I. M. BEATTY, Ossining, N. Y., assistant general manager of the Northern Westchester Lighting Company and the Peekskill Lighting & Railroad Company for the past 22 years, was recently appointed assistant to Vice-President Stuart Wilder of the Westchester Lighting Company, with headquarters in Mount Vernon. Mr. Beatty has been affiliated with the gas and electric industry in Westchester County for 33 years. It was in 1896 that he entered the employ of the old Hudson River Gas & Electric Company as assistant to the engineer in the company's plant at Tarrytown. After devoting some time to street and commercial lighting and meter indexing, he undertook some meter test work in the electrical department. He entered the electrical engineering department of the Westchester Lighting Company in Mount Vernon in 1902, and subsequently was connected with the Mount Kisco office, later removing to Tarrytown. In 1907 he was assigned to the Northern Westchester Lighting Company and the Peekskill Lighting & Railroad Company as assistant general manager.

J. A. Clay Heads Rocky Mountain Division

J. A. Clay, who was elected president of the Rocky Mountain Division of the National Electric Light Association at the recent convention in Glenwood Springs, Colo., as announced in the September 14 issue of the ELECTRICAL WORLD, has been general manager of the Western Colorado Power Company since its organization in 1913. A native of California, Mr. Clay received his engineering education at the University of California. He entered the employ

of the Independent Light & Power Company, San Francisco, and later engaged in electrical construction work in the Northwest at Tacoma and Seattle and also as an employee of the Washington Power Company. He was identified with the installation of electrical power in the Cœur d'Alene mining district, northern Idaho, for three years as electrical-mechanical engineer for the Hecla Mining Company.

It was in 1906 that Mr. Clay affiliated himself with the present Western Colorado Power Company, going to western Colorado for the Electric Bond & Share Company as general superintendent of the Animas Power & Water Company. On the acquisition of other properties, these and other companies were merged into the Western Colorado Power Company, of which Mr. Clay is general manager, with operating headquarters at Durango, Colo.

JOHN P. NEWTON, hydraulic engineer for New York State, is now in Augusta, Me., to make a survey of the local power situation and to assist the city in determining the value of the Augusta Canal in connection with the proposed municipal hydro-electric plant. Mr. Newton has been granted a leave of absence of several weeks by Governor Franklin D. Roosevelt of New York.

C. E. YACOLL has been named manager of the new industrial development department of the Penn-Ohio System.

PHILLIP GOSSLER, president of the Columbia Gas & Electric Corporation, has just returned from a two months' trip abroad.

HENRY L. DOHERTY, president of the Cities Service Company and an outstanding figure in the public utility field, has announced that he is planning to return to business after an absence of nearly three years due to illness.

J. C. BOYLE, manager of the Klamath division of the California Oregon Power Company, has been appointed to the position of assistant general manager of that utility, with headquarters in Medford, Ore. H. P. BOSWORTH, assistant secretary of the company, has been appointed division manager at Klamath to succeed Mr. Boyle.

R. C. HOPKINS, formerly assistant to the president of the Virginia Electric & Power Company, Richmond, Va., has been appointed assistant manager of the company at Fredericksburg. A graduate electrical engineer, Mr. Hopkins has been associated with Stone & Webster, Inc., for more than ten years and has been connected with the Virginia utility in the executive offices for the past three years.

HOWARD SMITH, general superintendent of the Citizens Gas & Electric Company, Waterloo, Iowa, from 1912 to 1917, and since then associated with utilities in that section of Iowa, will return to Waterloo October 1 as division manager for the Iowa Public Service Company, succeeding Ralph H. Garrison, who leaves to join the staff of the Utilities Power & Light Corporation, Chicago. Mr. Smith for the past two years has been division manager for the Iowa Public Service Company in Cherokee.

COLONEL THAD H. BROWN of Columbus, Ohio, has been appointed chief counsel of the Federal Power Commission to succeed Major Lewis W. Call, who is returning to the retired list of the army, from which he had been detailed to the commission. Colonel Brown was born in Morrow County, Ohio, and was graduated from Ohio Wesleyan University, later receiving his legal education at Ohio State University. He has been practicing law in Columbus since 1912, except for the period of the war. Colonel Brown was chairman of the Ohio State Civil Service Commission in 1920, 1921 and 1922. He resigned to become Secretary of State of Ohio and was re-

elected to that office in 1924. On his retirement from that office he reopened his law offices.

EDWIN B. KURTZ, for four years head of the department of electrical engineering at the Oklahoma Agricultural and Mechanical College, has been made professor and head of a similar department at the University of Iowa, succeeding Prof. Arthur H. Ford, who is on leave of absence because of ill health. The appointment was effective September 1.

E. J. SCHWANHAUSSER, for the past two years assistant manager of the Harrison works of the Worthington Pump & Machinery Corporation, has been appointed manager of that company's Buffalo works. Mr. Schwanhausser entered the employ of the Worthington organization while a student at Stevens Institute of Technology, during the summers of 1912, 1913 and 1914, having been connected with the various shops at Harrison.

M. C. KLING, manager of the St. Lawrence Utilities, Inc., Antwerp, N. Y., has severed his connection with that company. He has entered the General Electric School at Chicago for a three months' course, after which he will remove to Boston, Mass. He is a graduate of Purdue University and was with the St. Lawrence organization in Ogdensburg, N. Y., for four years previous to his connection at Antwerp a year and a half ago.

RALPH H. GARRISON, manager of the Cedar Valley division of the Iowa Public Service Company, with headquarters in Waterloo, Iowa, has resigned, effective October 1. Mr. Garrison will join the Utilities Power & Light Corporation with headquarters in Chicago. The Utilities Power & Light controls the Interstate Power and Central States Power & Light corporations, serving northeastern Iowa, Minnesota, northern Nebraska and parts of North and South Dakota. Mr. Garrison had been associated with the Iowa Public Service since 1924, succeeding Austin Burt as manager last year, when Mr. Burt resigned.

DALLAS J. FRANDSEN, formerly connected with the Edison Lamp Works, has joined the Public Service Company of Oklahoma in the capacity of lighting specialist. Mr. Frandsen is a graduate of the College of Engineering, University of Colorado. He has broad experience in the testing of lighting equipment, in preparing lighting equipment data on distribution, efficiency and lighting layout work. He will work under the direct supervision of J. A. Whitlow, manager for the Tulsa district, and will also assist in any lighting problems arising in any territory served by the company.

ALBERT VERMEER, secretary of the American Commonwealths Power Corporation, Grand Rapids, Mich., has been elected treasurer also, to succeed the late Frederick E. Webster. Mr. Vermeer will occupy both positions. A Hollander by birth, Mr. Vermeer removed to America with his parents in 1907, establishing residence at Grand Rapids. In 1922 he became secretary to Frank T. Hulswit, who was then president of the United Light & Power Company. When Mr. Hulswit left the United organization to become president of American Commonwealths Power, Mr. Vermeer also transferred his interests, and in 1927 was elected secretary of that company.

LOUIS S. LEAVITT, manager of the Lowell Electric Light Corporation, has been elected a director of the Lowell Chamber of Commerce. He is succeeding Leon E. Seekins, formerly manager of the electric light company.

R. W. LAMAR, chief engineer of the Birmingham Electric Company, Birmingham, Ala., since 1926, has resigned to become assistant general manager of the Knoxville Power & Light Company, Knoxville, Tenn. A graduate of Washington University, St. Louis, Mr. Lamar has had a broad background of engineering experience in various parts of the United States. His connections include the Washington Water Power Company, Spokane; Electric Bond & Share Company, New York; Interstate Public Service Company, Indianapolis; Central Power Company, Canton, Ohio; Monongahela West Penn Public Service Company, Fairmont, W. Va., and J. G. White Management Corporation.

Harry M. Edwards

Harry M. Edwards, whose death was announced in the September 21 issue of the ELECTRICAL WORLD, was for many years a prominent figure in the electric light and power industry. Within recent years the accountant has come to the foreground

as one of the most important constituents in the industry's personnel, and Mr. Edwards was one of the leaders in the movement which removed accounting from an incidental in central-station service to one of the most essential branches of the business.

A New Yorker by birth, Mr. Edwards entered the public utility field in 1889 as bookkeeper for the Manhattan Electric Light Company and its affiliated company, the Harlem Lighting Company, and within a short period was named auditor and subsequently secretary and a director. Later, following the merger of the Manhattan and Harlem companies with the Edison Electric Illuminating Company, he was appointed auditor of the Edison organization, assuming in addition the duties of auditor of the New York Gas, Electric Light, Heat & Power Company soon after its organization. In 1901 these companies were combined to form the New York Edison Company, and Mr. Edwards, in the rôle of auditor, had charge of the financial operations involved in the merger. It was toward the close of 1924 that he was elected vice-president in charge of accounting. He was vice-president and a director of the Yonkers Electric Light & Power Company and secretary, treasurer and a director of the Edison Light & Power Installation Company. He was a member of the accounting advisory committee of the system of five companies of which Matthew S. Sloan is president and a member of the standardization committee of these companies. Mr. Edwards was active in the National Electric Light Association, being at the time of his death a member of the executive committee, and also in the Association of Edison Illuminating Companies, the Electrical League of New York and similar organizations.

In the industry Mr. Edwards was looked upon as a wise counselor and willing co-operator. He was intimately concerned with the adoption of good accounting practices, the uniform classification of accounts and the development of utility rate systems. His wide experience in all branches of the industry gave him an understanding of the business that made him an extremely valuable committee worker and his personality and disposition won him friendship and respect among a host of men. His death marks the passing of one more pioneer who helped erect the structure that is the pride of electrical men. His life and work afford the highest example of an able utility executive devoted to his business and to the service it renders.

Financial and Statistical News

IT IS NO LONGER possible to speak of the stock market as a whole. It no longer moves as a whole. The market has become so definitely selective, especially within the past few weeks, that to characterize it as a strong market or a weak market is meaningless, at least with reference to a great proportion of trading sessions.

——MANY OF THE LEADERS THIS WEEK continued to make new highs, while probably as many stocks are at or near their low point for the year.

——DESPITE THE LIQUIDATION which seemed general the first part of the week, there is just as much variation in the market as a whole, during a typical trading session, as there is between a bull market and a bear market.

North American Offers $34,000,000 in Rights

For the first time since 1921 the North American Company has made an offering of stock subscription rights to shareholders. The new financing just announced will provide the company with about $55,000,000, which, presumably, is for further expansion of operating companies.

Under the new offering, stockholders of record of October 17 will receive rights to subscribe on or before November 15, at $100 a share, for additional common stock in the ratio of one share for each ten shares held. Warrants will be mailed about October 24 and subscriptions will be accepted for four shares only. Payment for the new stock may be made in full on or before November 15, or in four installments on or before November 15, 1929; January 2, April 1 and July 1, 1930.

According to Frank L. Dame, president, the policy of the company of paying dividends in common stock at the rate of 10 per cent annually will not be changed as a result of this financing. At a price of 168 the rights to purchase stock are worth about $6.20 each and there are 5,481,841 shares outstanding.

General Gas Directors Sanction Five-for-One Split

Directors of the General Gas & Electric Corporation at a special meeting held September 23 voted, subject to the approval of stockholders, to split the class A and class B common shares on the basis of five new for each share outstanding.

Five of the new class A shares will be exchanged for each present class A share and five new class B shares for each class B now issued. The new class A common shares will carry priority dividends at the rate of one-fifth the amount of the priority dividends on the present class A shares, and after payment of a like amount on the class B common stock will fully participate on a per share basis in additional dividends. It is expected that the policy of paying an extra annual dividend on the class A common will be continued after the split-up.

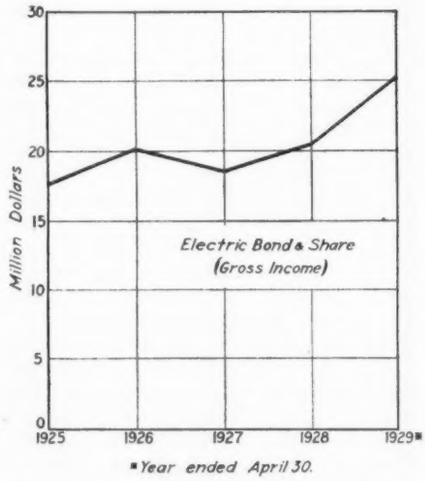
COMMONWEALTH & SOUTHERN OUTPUT ADVANCES.—Electric output of the Commonwealth & Southern Corporation system in August was 534,307,000 kw.-hr., an increase of nearly 9 per cent over August of last year. For the eight months ended August 31, 1929, total output was 4,207,609,000 kw.-hr., an increase of more than 12 per cent over the corresponding period of 1928. Total output for the year ended August 31, 1929, exceeded 6,215,000,000 kw.-hr.

Central & South West Utilities Splits Stock

Stockholders of the Central & South West Utilities Company have increased the authorized no-par value common stock from 750,000 shares to 3,750,000 shares and approved the issuance of five new shares for each share held. The directors propose to pay dividends on the new or split shares of common stock in the form of common stock at the annual rate of 4 per cent of the number of shares of common stock held.

Electric Bond & Share Merger Approved by Directorates

A FURTHER step was taken this week in the recently announced merger of Electric Bond & Share Company and Electric Investors, Inc., when the directors of both companies approved a plan of exchange of stock. Shareholders will be asked to ratify the basis at the annual meeting, October 9.



Income of Parent Company Shows Steady Expansion

The plan as approved provides for the acquisition of Electric Investors by Electric Bond & Share Company by an exchange of eight shares of the latter company's common stock for five shares of Electric Investors common. The preferred stock is to be exchanged share for share or, as an option, Electric Investors shareholders may receive $100 a share and accumulated dividends for their preferred stock. At the market close Sept. 24 eight shares of Electric Bond & Share common would amount to $1,454 and five shares of the investment trust stock around $1,410, giving the market an opportunity to bring the two somewhat closer together by arbitrage operations.

Union of these two utility groups will create one of the world's largest utility investment companies. As of April 30, Electric Bond & Share owned 14 per cent of all classes of stock of American Power & Light, 21 per cent of that of Electric Power & Light, 29 per cent of that of National Power & Light and 8 per cent of the shares of American Gas & Electric Company. The common stocks of the companies named owned by Electric Bond & Share represent 24 per cent of the outstanding issue of American Power & Light, 18 per cent of Electric Power & Light common stock and 46 per cent of option warrants for common shares, 31 per cent of National Power & Light common and 9 per cent of American Gas & Electric common. Thirteen per cent of the common shares of Electric Investors is owned by Electric Bond & Share, and the latter has investments in Commonwealth & Southern and other companies.

Approximately 90 per cent of Electric Investors' holdings were recently in

thirty-seven utility companies. The principal of these, in the order of market values at June 30, are American Gas & Electric, Commonwealth & Southern, National Power & Light, United Corporation, American Power & Light, Electric Power & Light, North American, American Water Works & Electric, American Superpower, Columbia Gas & Electric, International Telephone & Telegraph, Consolidated Gas of New York, American & Foreign Power and United Light & Power.

United Corporation Shows Huge Profits

An example of the investment company possibilities in the current utility market is seen in the experience of the United Corporation. During the past two months or so the assets of this organization have appreciated slightly more than $65,000,000 in market value. Based on closing prices September 19 stocks in the portfolio of the corporation on June 19 show an appreciation since January, 1929, when the corporation was formed, indicating a profit in security holdings in excess of $205,000,000, or practically $30 a share on the common stock.

Net value of assets as of September 19 was approximately $430,718,000, which is the equivalent of approximately $51.50 per share. The stock is currently quoted around 70.

MANHATTAN ELECTRICAL SUPPLY STOCK LISTED.—The New York Stock Exchange has authorized the listing of 50,000 shares of common stock (no par value) of the Manhattan Electrical Supply Company, Inc., on official notice of issuance and payment in full, making the total amount applied for 250,000 shares.

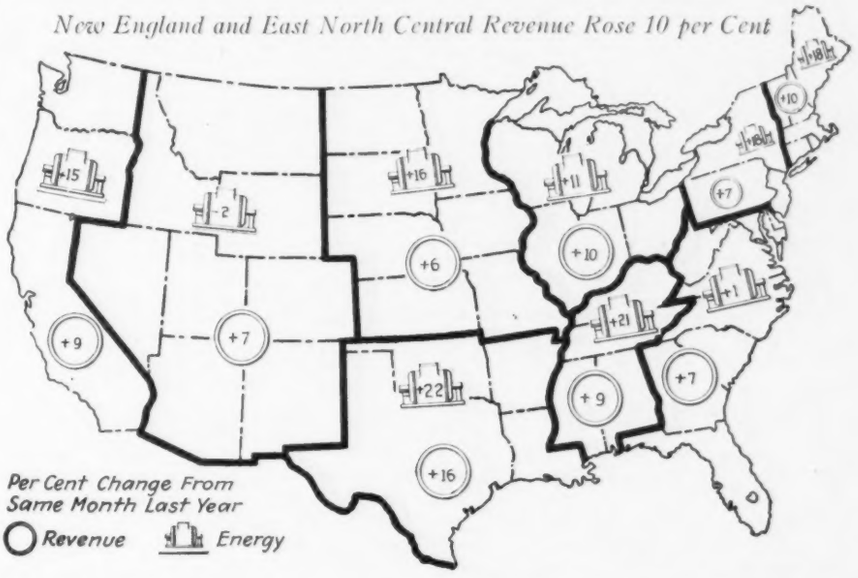
PHILADELPHIA COMPANY DECLARES EXTRA DIVIDEND.—The board of directors of the Philadelphia Company has declared a quarterly dividend of $1 and an extra dividend of 75 cents a share on the common stock, both payable October 31 to shareholders of record October 1, and $1.50 a share semi-annually on the 6 per cent cumulative preferred stock, payable November 1 to shareholders of record October 1.

Light and Power Progress Continues

Revenue, $159,300,000, 8.7 per Cent Above Last Year —Energy Output Gains 13 per Cent—Water Scarcity Still Serious

AFTER electric light and power operations for the first half year had shown an increase, compared with 1928, of 8.7 per cent in gross revenue and 13.5 per cent in energy generated, July operations continued virtually the same rate of progress. The revenue is estimated at $159,300,000, with possible slight changes on the receipt of additional reports; this exceeds the revenue of July, 1928, by 8.7 per cent. The energy output, 7,643,129,000 kw.-hr., is 13 per cent greater than it was a year ago.

New England and East North Central Revenue Rose 10 per Cent



These gains over 1928 are to be particularly noted because the summer and fall months of that year in themselves had brought more than the normal seasonal increase over the operations of the preceding spring. Consequently, in both respects the operations for the current year are well above the estimated normal, as is evident from the accompanying chart.

Operating expenses appear to have risen a trifle more, proportionately, than revenue, attaining a total of 70,000,000, but since the factors that determine the expenses are not necessarily in close step with those that determine the revenue, and since in general the expenses have been increasing less rapidly than the revenue, the slight deviation, during a given month, from that rule is probably of no significance.

From Table III it will be seen that the scarcity of water power persists. The output from this source, 2,979,860,000 kw.-hr., was less than 1 per cent in excess of the corresponding output a year ago. The output from fuel, therefore, had to be increased 23.2 per cent to make up the necessary total. Incidentally, this is the greatest increase for any month since January. These persistently high gains in output from fuel, about 20 per cent greater thus far in 1929 than in the corresponding period of 1928, are evidence of the increasing necessity of having adequate steam equipment to fall back upon, when the dry spells come.

The increasing output of steam plants

Table I—Central-Station Financial Operations in the United States

Compared with Corresponding Month of Previous Year

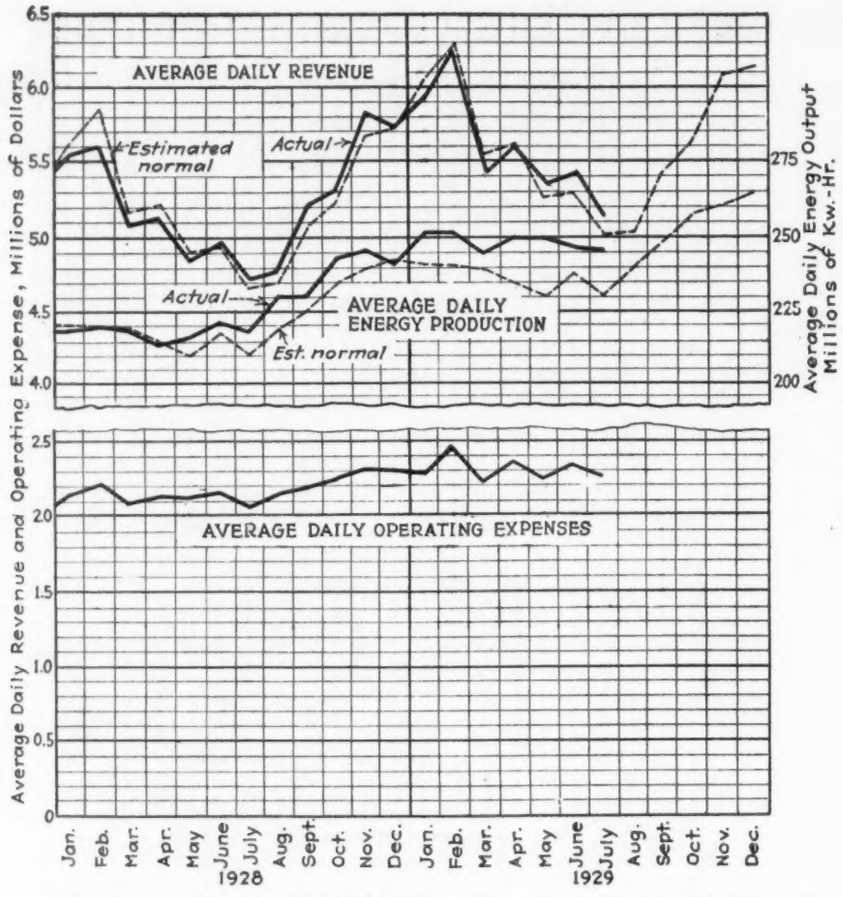
Month	Total Gross Revenue from Sale of Energy*			Total Operating and Maintenance Expense†		
	1929 Thousands	1928 Thousands	Per Cent Inc.	1929 Thousands	1928 Thousands	Per Cent Inc.
April	$168,100	$153,800	+ 9.4	$70,400	$64,100	+9.8
May	165,600	150,100	+10.3	70,950	65,700	+8.1
June	162,300	149,500	+ 8.6	69,600	64,800	+7.4
July	159,300	146,600	+ 8.7	70,000	64,100	+9.2

Table II—Central-Station Fuel Consumption in the United States‡

Compared with Corresponding Month of Previous Year

Month 1929	Coal		Oil		Gas	
	Short Tons	Per Cent Increase	Barrels	Per Cent Increase	Thousands Cubic Feet	Per Cent Increase
April	3,134,744	+11.7	613,207	+21.0	7,805,763	+47.2
May	3,096,874	+ 9.7	566,953	+22.8	8,485,388	+48.0
June	3,137,880	+14.0	585,255	+22.7	8,803,957	+41.4
July	3,303,818	+14.8	679,936	+28.1	8,697,854	+24.9

*Aggregate gross revenue from consumers and from other utilities for energy for resale, involving a certain amount of duplication.
†Do not include interest, taxes, depreciation or sinking fund, with some unavoidable exceptions. ‡As collected by U. S. Geological Survey.



July Output Nearly 50,000,000 Kw.-Hr. Above Estimated Normal

has called for increased fuel consumption. Nearly 15 per cent more coal was burned than a year ago, the total consumption being 3,303,818 short tons. Oil and gas have moved with coal, as will be seen from Table II. Two-thirds of the gas is used in the four West South Central States; more than half of the total in Texas and Louisiana alone.

Although seasonal fluctuations have been the rule in former years, the average daily output during the past seven months has shown remarkably slight variations, month by month.

Analyzed by regions, the greatest gain again occurred in the West South Central States; 16.2 per cent more revenue than a year ago and 22.2 per cent more energy output. The gains over last year in New England are particularly notable, nearly 10 per cent in revenue and 18 per cent in energy generated.

A comparison of operations in adjacent regions, as presented in Table IV and the map, reveals some of the consequences of the scarcity of water power and the alleviation of the situation thus brought about by interconnection. It is quite apparent that power deficiencies were thus smoothed out because the revenue shows no such violent fluctuations as might be expected in view of the variations in energy output.

Table III—Energy Output of Central Stations in the United States

Compared with Corresponding Month of Previous Year

Month 1929	Generated, Thousands of Kw.-Hr.*						Purchased for Resale	
	Total		Hydro		Fuel			
	Generated	Per Cent Inc.	Generated	Per Cent Inc.	Generated	Per Cent Inc.	Thous. Kw.-Hr.	Per Cent Inc.
April	7,506,484	+16.9	3,210,363	+13.4	4,296,121	+19.5	1,549,000	+16.5
May	7,706,345	+14.6	3,395,320	+10.5	4,311,023	+18.1	1,571,000	+ 6.0
June	7,406,737	+11.5	2,984,759	— 8.5	4,421,978	+21.9	1,580,000	+ 4.5
July	7,643,129	+13.0	2,979,860	+ 0.8	4,663,269	+23.2	1,480,000	+ 7.2

Table IV—Regional Operations, Revenue and Energy Output in July, 1929

Compared with Corresponding Month of Previous Year

Region	Revenue		Energy Generated Thousands of Kw.-Hr.*					
			Total		Hydro		Fuel	
	Thousands of Dollars	Per Cent Inc	Generated	Per Cent Inc.	Generated	Per Cent Inc.	Generated	Per Cent Inc.
United States	159,300	+ 8.7	7,643,129	+13.0	2,979,860	+ 0.8	2,771,314	+23.2
New England	15,170	+ 9.8	478,401	+17.8	142,039	—22.7	110,852	+51.3
Middle Atlantic	39,560	+ 7.1	1,801,123	+18.3	483,319	—11.3	303,877	+34.7
East North Central	40,760	+10.1	1,814,374	+11.2	219,487	+ 7.4	202,039	+11.8
West North Central	12,540	+ 5.9	457,384	+15.9	145,492	+ 6.1	137,665	+21.2
South Atlantic	16,780	+ 7.4	900,696	+ 1.4	474,970	— 9.6	466,784	+17.3
East South Central	5,620	+ 8.7	283,616	+21.1	227,938	+18.9	229,463	+30.5
West South Central	8,930	+16.2	425,060	+22.2	4,460	+27.0	4,181	+22.2
Mountain	4,270	+ 6.7	338,548	— 1.9	286,100	— 9.1	295,313	+70.2
Pacific	15,670	+ 8.5	1,143,927	+15.3	996,055	+14.2	1,021,140	+23.8

*As collected by U. S. Geological Survey.

New Capital Issues

Mid-West States Utilities Company made an offering of 6 per cent convertible gold notes during the week ended September 26, a piece of financing involving a total of $1,200,000. This company and its subsidiaries furnish electric power and telephone service in Illinois, Wisconsin, Arkansas, Oklahoma and Texas. The notes will be convertible at the option of the holder at any time on or prior to maturity into a like principal amount of convertible 6½ per cent sinking fund gold debentures due July 15, 1939. The debentures into which these notes are convertible will be convertible into 40 shares of class A common stock of the company for each $1,000 debenture to and including April 15, 1931, and thereafter into 35 shares class A common stock.

Three-year convertible 6 per cent gold notes of the Federal Public Service Corporation to the amount of $4,000,000 were offered the investing public at 97¼ and interest, yielding over 7 per cent. These notes were used in connection with the recent acquisition by the company of additional subsidiaries serving approximately 27,700 customers. They may be converted prior to maturity into class A participating common stock of Union Power Corporation (the owner of the entire outstanding common stock of the Federal Public Service Corporation) as constituted at the time of conversion on the basis of four shares of the present class of class A participating common stock which is without par value, for each $100 principal amount of notes, with adjustment of accrued interest.

PUBLIC SERVICE ELECTRIC TO ISSUE STOCK.—The New Jersey Public Utilities Commission has authorized the Public Service Electric & Gas Company to issue 1,175,000 shares of no-par common stock. The proceeds will be used to reimburse the corporation for additions and improvements already made and to be made.

Business News and Market Conditions

Seasonal Decline in Manufacturing

REPORTS received by the ELECTRICAL WORLD from a large proportion of the electrical manufacturing plants of the country indicate that a seasonal curtailment in rate of activity was witnessed in August as compared with July, although the productive operations were still above those of August last year.

Rate of operations during August was 6.7 per cent under July and 8.9 per cent under June, the record month for the industry. August operations, however, were still at a rate 30.1 per cent over August last year. It appears now that for the first time in recent years the peak of operations during the year were recorded during the summer months in 1929. As a rule the summer months have witnessed the lowest rate of activity for the year rather than the highest.

The reports on electrical energy consumption indicate that the larger manufacturers are maintaining their productive operations in a better position than the group of smaller companies. The larger companies recorded an average decrease in operations of 1.4 per cent as compared with July and were operating on a plane 44 per cent above August last year. On the other hand, the small electrical manufacturing plants recorded a drop in rate of operations of 9.3 per cent as compared with July and were operating at a rate 24 per cent above August last year.

The index of activity in the electrical manufacturing industry, based on consumption of electrical energy, stands at 155.4 for August as compared with 119.4 in August last year. Comparative indexes of productive activity referred to the average activity for the period 1923-25 as 100 and adjusted for number of working days are shown in the table in the first column.

August, 1929	155.4
July, 1929	166.6
June, 1929	170.5
May, 1929	163.5
August, 1928	119.4
Average first eight months 1929	155.3
Average first eight months 1928	121.2

New York Metal Market Prices

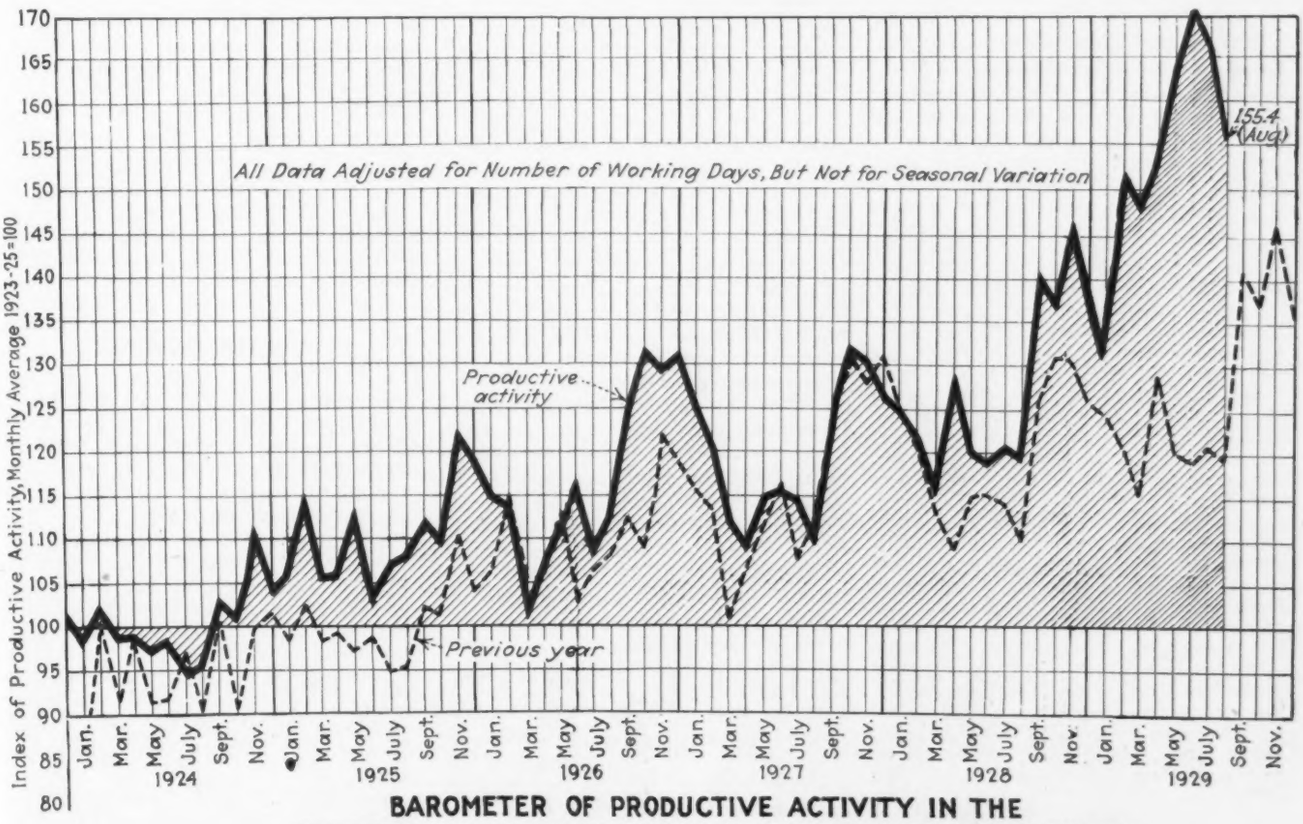
	Sept. 18, 1929 Cents per Pound	Sept. 25, 1929 Cents per Pound
Copper, electrolytic	18	18
Lead, Am. S. & R. price	6.90	6.90
Antimony	8.75	8.75
Nickel, ingot	35	35
Zinc, spot	7.15	7.15
Tin, Straits	45.12	45.12
Aluminum, 99 per cent.	24.30	24.30

Delinquent Electrical Accounts

Division	July 1928	July 1929	Per Cent Change	Seven Months 1928	Seven Months 1929	Per Cent Change
New York	265	231	— 5.2	2,135	1,718	—19.5
Middle and Southern Atlantic	149	152	+ 2.0	1,283	1,127	—12.1
New England	99	58	—41.4	852	1,027	+20.5
Central	663	566	—14.6	5,829	4,458	—20.8
otal	1,176	1,027	—12.6	9,899	8,330	—15.8

TOTAL AMOUNTS REPORTED

	July 1928	July 1929	Per Cent Change	Seven Months 1928	Seven Months 1929	Per Cent Change
New York	$38,813	$53,423	+37.6	$307,816	$395,984	+28.6
Middle and Southern Atlantic	25,584	24,072	— 5.9	168,702	164,905	— 2.2
New England	12,901	9,317	—27.7	109,163	140,826	+28.8
Central	72,945	59,354	—18.6	672,578	544,877	—18.9
Total	$150,243	$146,166	— 2.7	$1,258,259	$1,246,392	— .9



BAROMETER OF PRODUCTIVE ACTIVITY IN THE ELECTRICAL MANUFACTURING PLANTS OF THE UNITED STATES

Market Conditions

EQUIPMENT BUSINESS on the Pacific Coast is still below par, but seasonal improvement is seen elsewhere. Refrigeration and street lighting orders feature a very satisfactory volume of business in the Eastern district.

——OIL-BURNING EQUIPMENT stands out this week in New England.
——TRANSFORMERS AND METERS are slightly more active in the Southeast.

——CONSTRUCTION IS ACTIVE in the mining sections of the Middle West.

MIDDLE WEST

GENERAL business in the Middle West section continues to show improvement. Railroad purchasing has held up extremely well all through the year and is particularly heavy at this time. Considerable construction work is going on in the coal mining sections. The various utility companies are busy with a large amount of circuit revision and line extension work, with some new construction going on.

One of the interesting orders placed this week was for erection of electrical equipment used with unit No. 3 of the Powerton, Ill., generating station, valued in excess of $1,000,000. Jobbers' sales are normal. The electrical exposition held in the electric shops of the Commonwealth Edison Company, Chicago, is causing considerable interest to be displayed by the buying public in the various electrical appliances, particularly waffle irons and automatic toasters. Prices remain generally firm. Construction projects follow:

Appleton, Wis., will receive bids until October 2 for an ornamental lighting system. Clarks Mills Flour Company, Clarks Mills, Wis., is said to be planning a hydro-electric power plant on the Manitowoc River. Wisconsin Power & Light Company, Madison, Wis., contemplates a power substation at Clintonville, Wis. Fort Howard Paper Company, Green Bay, Wis., will build a three-story addition to mill to cost about $100,000. Little Wolf Power Company, Clintonville, Wis., plans hydro-electric power plant to cost about $90,000. Line Material Company, South Milwaukee, Wis., will build an addition to electric equipment manufacturing plant, reported to cost $75,000. Michigan Bell Telephone Company, Detroit, Mich., has filed plans for a storage and distributing plant, with electrical division, to cost $1,000,000. Michigan College of Mining and Technology, Houghton, Mich., plans electrical and mechanical engineering building to cost $350,000. Consumers Power Company, Jackson, Mich., will build a hydro-electric power plant at Morley, Mich., to cost about $10,000,000, with transmission system. United Brass & Aluminum Manufacturing Company, Port Huron, Mich., plans rebuilding of portion of plant recently destroyed by fire with loss of about $200,000. Eugene Dietzgen Company, Chicago, Ill., plans addition to drawing material manufacturing plant to cost $225,000. Inter-State Aviation Corporation, Chicago, Ill., plans installation of floodlighting system and beacon lamps at proposed Lorraine airport. Norton Company, Worcester, Mass., has filed plans for abrasive materials factory branch at Chicago, Ill., to cost $200,000. Evans-Wallower Lead Company, St. Louis, Mo., plans an electrolytic smelting plant at East St. Louis, Ill., to cost $250,000. B. F. Goodrich Company, Akron, Ohio, plans rubber mill at Buenos Aires, Argentina, reported to cost $400,000. William S. Merrell Company, Cincinnati, Ohio, plans addition to drug and chemical plant to cost $200,000. Thompson Products, Inc., Cleveland, Ohio, plans automotive equipment manufacturing plant at St. Catharines, Ont., to cost $175,000. Green & Green Company, Dayton, Ohio, will build an addition to cracker factory to cost $400,000.

PACIFIC COAST

SEPTEMBER business on the Coast is unusually small, both for standard and special material, with, however, a $1,000,000 order for synchronous condensers, oil circuit breakers and 20,000-kva. transformers for a central California installation to be placed this month. The week's outstanding order covers three carloads of Westinghouse ranges distributed between Seattle and San Francisco jobbers.

A 6,000-kva. Diesel plant has been recommended instead of the five hydro plants previously recommended for the $2,000,000 Imperial Valley irrigation project. Prospective business covers a 300-kva. generator for a hospital and a $100,000 station addition at Alturas. Power company ordering is very light. Large prospective construction includes $1,000,000 hotels at Hollywood and La Jolla, a $750,000 apartment hotel in San Francisco, a $3,000,000 building for the Los Angeles Athletic Club and a $3,500,000 state prison in Los Angeles County. Railroad work includes a 150-mile copper-dispatching circuit between Wendel and Lakeview and a 100-mile copper circuit between Oakland and Napa.

Motor and apparatus sales in the Seattle district last week were very light, but there is good business in immediate prospect. Range and domestic appliance sales are satisfactory. Preliminary plans for construction of a $2,000,000 hydro-electric plant at Sunset Falls, on the Skykomish River, generating 20,500 hp., are announced by the Puget Sound Power & Light Company. A Seattle purchasing agent is taking bids for 100,000 lb. of triple-braid soft-drawn solid copper wire, 350 cedar poles and 48,000 ft. of power cable. The board of contracts and awards, Tacoma, is taking bids for one 125-ton, four-motor electric crane, one oil purifier and for two electric controls of 48-in. gates at McMillin reservoir and a purchasing agent at Spokane is taking bids for one 900-hp. motor and starting equipment.

The General Electric Company's Seattle office received a contract for four 260-ton electric locomotives from the Great Northern Railway to be used in the electrified zone between Skykomish and Wenatchee, Wash., over the Cascade Mountains. They are said to be the largest single-cab units of the motor-generator type in the world and will cost about $1,000,000. Construction projects follow:

San Leandro, Calif., will receive bids until October 2 for an ornamental lighting system. Santa Cruz, Calif., plans installation of floodlighting system and beacon lamps at proposed municipal airport. Los Angeles, Pomona, and Alameda, Calif., plan ornamental lighting systems. Fokker Aircraft Corporation, Glendale, W. Va., plans plant at Los Angeles, Calif., to cost about $300,000. Mountain States Power Company, Tacoma, Wash., will build a steam-operated electric generating plant at Marshfield, Ore., capacity 10,000 kw., to cost about $1,000,000; a transmission line will be built from Marshfield to Dixonville, 65 miles. Medford, Ore., will take bids for floodlighting system and beacon lamps at municipal airport. Northwest Power Company, Portland, Ore., is reported planning hydro-electric power plant in vicinity of Lake Marion to cost more than $350,000. Northwest Magnesite Company, Chewelah, Wash., contemplates an addition to plant to cost more than $100,000. Puget Sound Pulp & Timber Company, Everett, Wash., is completing plans for a pulp mill to cost $2,000,000; contract for power has been given to the Puget Sound Light & Power Company, Seattle. Pend O'reille Mines & Metals Company, Spokane, Wash., has plans completed for an electrolytic zinc mill at Metaline Falls, Wash., to cost $1,500,000.

SOUTHWEST

THERE has been no decided change in the general business in the St. Louis district. The trend is still upward and ahead in volume of last month as well as the same period last year.

The only contracts worthy of mention are control equipment for frequency-changer sets in a local substation, 20,000 kva., amounting to $25.000, and switchboard equipment for one of the mining companies in the lead district worth $18,000. Jobbers report appliances moving in good quantity and a good demand for construction materials. Construction projects follow:

State Dairy Products Company, Columbia, Mo., plans plant at Jefferson City, Mo., to cost $85,000. Sedalia, Mo., plans installation of floodlighting system and bea-

con lamps at proposed municipal airport. Russellville, Ark., has authorized a bond issue of $200,000, for construction of municipal electric light and power plant. Center, Tex., plans municipal electric light and power plant to cost about $90,000. Corpus Christi, Tex., plans installation of beacon lamps at municipal airport. Atlas Metal Works, Inc., Dallas, Tex., will build an addition to cost $150,000. Central Power & Light Company, San Antonio, Tex., will install a lighting system at Devine, Tex. Florida Public Service Company, Orlando, Fla., plans extensions and improvements in ice-manufacturing plant at Eustis, Tex., to cost about $50,000. Houston Galvanizing & Plating Company, Houston, Tex., plans an addition to cost about $80,000. Bogalusa, La., plans ornamental lighting system.

EASTERN

THE CLOSE of September shows the electrical market in the Eastern district at the same high point of activity as characterized the beginning of the month. There is still vim and snap in the situation; equipment for railway electrification is still in prominence and forms a feature of current sales. Central stations are placing sizable commitments for this time of year, and during the concluding days of the month industrial orders have been swinging upward to appreciable sums.

An outstanding transaction in the local market is the order placed by the Delaware, Lackawanna & Western Railroad Company with the General Electric Company for substation equipment for five such operating units at different points along the lines to be electrified in New Jersey, including transformers, rectifiers, controls and auxiliary apparatus, said to total close to $1,000,000. Another important project is the proposed electrification of the double track of the Grand Trunk Railway System from Detroit to Pontiac, Mich., about 25 miles, on which work is scheduled to begin in January. It is estimated to cost close to $15,000,000; orders for equipment will be placed at an early date and a contract is being made with the Detroit Edison Company for power service.

Industrial demand for electrical equipment is broadening at New York and vicinity and a group of basic industries are in the market for requirements. Fractional-horsepower motors are in better demand and the outlook for sales is encouraging. Several steel mills in Ohio and northern New York are promising prospects for heavy-duty motors and control apparatus. Central stations continue with an active call for substation equipment. A central station at Buffalo, N. Y., has given a commitment for transformer units to the sum of $330,000, including auxiliaries. Electric refrigerating equipment is operating under good demand and the majority of plants devoted to this line are running on a maximum production schedule. Ornamental street-lighting equipment is showing strength for the fall season and early sizable bookings are anticipated. Construction projects follow:

Signal Supply Officer, Signal Section, New York General Depot, Brooklyn, will receive bids until October 8 for 104,000 ft. of cable and 500,000 ft. of wire (Circular 26). New York Trade School, New York, will build an addition to cost $500,000. National Paper Products Company, Carthage, N. Y., will make extensions and improvements in mill to cost more than $100,000. Shell Eastern Petroleum Products Company, New York, will build a storage and distributing plant at Schenectady, N. Y., to cost about $100,000. Albany Corrugated Container Corporation, Albany, N. Y., will carry out an expansion program to cost more than $100,000. Standard Oil Company of New Jersey, New York, plans a storage and distributing plant at Asheville, N. C., to cost $250,000. Bakelite Corporation, New York, is having plans drawn for insulating material plant at Bound Brook, N. J., to cost more than $400,000. Calco Chemical Company, Bound Brook, N. J., will build additions to cost close to $80,000. Perth Amboy, N. J., contemplates installation of street lights on several thoroughfares. Philadelphia Electric Company, Philadelphia, has filed plans for a machine shop on Luzerne Street. Northern Pennsylvania Power Company, Binghamton, N. Y., plans extensions in system in Tioga and Lycoming Counties, Pa. Apex Hosiery Company, Philadelphia, Pa., has filed plans for a knitting mill to cost $120,000. Crown Silk Company, South Bangor, Pa., will carry out an expansion and improvement program to cost $200,000. Firestone Tire & Rubber Company, Akron, Ohio, will build a factory branch and distributing plant at Pittsburgh, Pa., to cost $200,000. Consolidated Gas, Electric Light & Power Company, Baltimore, Md., contemplates extensions in transmission lines in Montgomery County. W. B. Tilghman, Jr., Salisbury, Md., plans fertilizer manufacturing plant at Pocomoke City, Md., to cost $50,000. Bureau of Supplies and Accounts, Navy Department, Washington, D. C., will receive bids until October 8 for insulated wire and cable for Eastern and Western yards (Schedule 1765); at same time, for two oil-generating units for the Puget Sound Navy Yard (Schedule 1783). The General Purchasing Officer, Panama Canal, Washington, D. C., will receive bids until October 11 for switchboard, meter-testing blocks, electric fixtures and other equipment (Panama Canal Schedule No. 1995).

NEW ENGLAND

A STEADY movement in small orders and less activity in heavy power development and control equipment were noted in this district during the past week. The sales volume in small motors reported by one manufacturer was encouraging and substantial orders in small motors were noted by another. The interest in fractional horsepower motors is increasing among manufacturers of oil-heating equipment.

The outlook for continued heavy demand from machine tool manufacturers in this district is promising. Small switches and control apparatus are active. Negotiations are under way for line materials. New service line extensions are being considered in western Massachusetts and in northeastern Massachusetts. A 110,000-volt transmission line is projected as a link with the new Woburn substation. Central-station equipment buying for the fall is encouraging in view of the probability of continuance of work within the Central Maine Power Company area. General scheduled material sales are steady; new construction requirements have dropped off recently and less activity is reported. Merchandising sales are steady and show an increase in volume over that reported for last year for the first three quarters. Oil burning equipment, refrigerating units and domestic electric appliances all show steady demands. Construction projects follow:

Benz Kid Company, Lynn, Mass., has filed plans for an addition, reported to cost about $80,000. Chance Vought Corporation, Long Island City, N. Y., will soon begin construction of an aircraft plant at East Hartford, Conn., to cost about $750,000, with equipment. Welte Organ Company, New York, will establish a plant at Sound Beach, Conn., to cost more than $200,000.

SOUTHEAST

SATISFACTORY business, with a few large orders, but the majority of small, individual size, is reported in the electrical field of the Southeast. The movement of transformers and meters is more active than in recent weeks. A draft fan was ordered for a new steam station in Georgia, while some other central-station orders were for bare copper wire, weatherproof wire, insulators and conduit.

A paper mill in Louisiana placed two orders for electrical mill equipment totaling $330,000 and a Georgia mill ordered a static condenser and undervoltage time delay equipment for a group of plants, this order amounting to $7,500. Wiring materials amounting to $8,000 were ordered for the new Southern Bell Telephone building in Atlanta. Construction projects follow:

Reynolds Metal Company, Louisville, Ky., is completing plans for an aluminum powder mill to cost about $100,000. Everwear Hosiery Company, Chattanooga, Tenn., plans an addition to cost $75,000. Johnson City, Tenn., plans extensions in ornamental street-lighting system. Benson, N. C., contemplates installation of municipal electric light and power plant, and will have estimates of cost made at once. Union Bleachery, Inc., Greenville, S. C., plans power plant to cost $100,000, in connection with mill expansion program to cost $300,000. Sumter, S. C., plans installation of floodlighting system and beacon lamps at proposed municipal airport. Gulfport, Miss., plans installation of floodlighting system and beacon lamps at municipal airport. Alabama Power Company, Birmingham, plans transmission line from Enterprise to Florala, Ala., about 35 miles. Augusta, Ga., contemplates a municipal hydro-electric power plant, reported to cost more than $175,000. Georgia Power Company, Atlanta, Ga., plans extensions and improvements in plant and system at Cedartown, Ga., including new lines.

Activities of the Trade

Crocker-Wheeler Electric Votes Ten-for-One Split

Directors of the Crocker-Wheeler Electric Manufacturing Company have voted to recommend a split-up of the common stock on the basis of ten new shares for each share of the present stock held. A meeting of the stockholders has been called for October 10 for the purpose of ratifying this arrangement and of approving the increase in the number of shares of common stock from 40,000 shares to 400,000 shares, to provide the necessary stock involved in the split. At present there are outstanding 23,240 shares of common stock, which will be increased ten times, as well as 8,632 shares of 7 per cent preferred stock. The company has no funded debt.

This announcement calls to mind the rapid market appreciation of some of the equipment stocks. In 1927 Crocker-Wheeler's common stock range was 37-22. In 1928 it was 150-27. This year to date the range is 740 high and 127½ low. In other words, 100 shares purchased two years ago around $2,500 would now have a market value of $74,000.

THE MONOWATT ELECTRIC CORPORATION, Bridgeport, Conn., has been formed to take over the business and plants of the Monowatt Corporation of New York, the Connecticut Molded Products Corporation, Meriden, Conn., and the New England Metal Products Company, Meriden, Conn. The company will operate in its own factory for the production of hot and cold molded products and will have a plant especially adapted to the fabrication of the brass parts required in the manufacture of wiring devices.

General Motors Enters Electrical Equipment Field

With the purchase of the Northeast Electric Company of Rochester, a $13,000,000 transaction, the General Motors Corporation has entered the electrical equipment field. This represents a further step in the diversification by General Motors of its operations. Starting with the production of automobiles, it entered the electrical refrigeration field, later producing ethyl gasoline, radio and, finally, electrical equipment.

In connection with the present acquisition, it was announced that the entire assets of Northeast Electric Company had been acquired by the payment of 40,000 shares of its 7 per cent preferred stock and 206,000 shares of common stock. This is the equivalent, at current market prices, of around $13,000,000. The Northeast Electric plant will continue to manufacture automotive and electric parts, it is understood. Stockholders of Northeast Electric Company have ratified the transaction. According to an announcement made, William A. Montgomery, president of the Northeast Electric Company, and James J. Stafford, treasurer, will retire from the company, while the balance of the personnel will continue under the direction of Edward A. Halblieb, vice-president and general manager.

WAGNER ELECTRIC COMPANY, St. Louis, announces the appointment of J. V. Holston as branch manager of the St. Louis sales office. Mr. Holston received his training at the Wagner plant as a student engineer and was later transferred to Chicago territory as a specialty salesman of power factor correcting, and he later represented the entire Wagner line of motors, transformers and fans.

THE FEDERAL ELECTRIC COMPANY, Chicago, Ill., has concluded arrangements for the purchase of the plant and business of the Loper Fire Alarm Company, Stonington, Conn., established about eighteen years ago by A. P. Loper, who has been head of the organization since that time. The purchasing company will consolidate with its organization, removing the Stonington plant to Chicago at an early date.

European Economic Union and Tariff Policies

AMERICA is more likely to benefit than to suffer as a result of the proposed European Zollverein or economic union, an outstanding authority on international relationships told members of the McGraw-Hill staff recently. "Although any definite appraisal of such an eventuality is yet premature," said the speaker, "any fundamental contribution to European prosperity and general economic stability will react favorably upon the buying power of the Old World." Such a result would greatly expand markets for American goods.

Relative to the outcry in certain sections of Europe against the United States tariff policy, it was the opinion of the speaker that such protests are in some degree justified. On the other hand, they are frequently an attempt by politicians to secure a united front at home by pointing to some fictitious ogre abroad. One possible ground of protest is the tendency to protect certain microscopic industries which have no economic justification for protection.

Turning to a discussion of the tariff walls of some of those nations prone to criticise the United States tariff, the speaker proceeded:

The findings of the League of Nations tariff investigators as to comparative levels, though obviously incomplete in many respects, nevertheless showed clearly a marked tendency toward high levels in certain European countries. For example, the Spanish index placed her at the top of nineteen countries in terms of rates of customs duties, even exceeding the United States.

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Even more important in certain respects is the prevalence of certain discriminatory devices and other forms of trade barriers against American goods in Europe. A few of these are quite evidently intentional, whereas many others are simply part and parcel of the run of European tariff policies and administration.

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Even more vexatious are certain administrative devices and classification policies which are recurring in European tariffs. For instance, Poland, with a zeal for developing direct trade with the United States, assesses heavy duties upon all shipments moving in through indirect channels. This is a special penalty upon American cargoes, few of which are large enough to warrant direct consignment to Poland and, therefore, move in small lots of redistribution from Hamburg and Copenhagen.

* * *

A similar situation arises in the Swiss practice of assessing tariffs in part so as to include tare for containers, crates, etc. Major items in our sales to Switzerland are automobile products, most of which come in over the road "on the hoof" from our European competitors, and we, therefore, suffer sharp discrimination because of our isolation. In part, this may be met by shipments of American cars from branch factories and assembly plants in Belgium, Holland, Germany and Italy.

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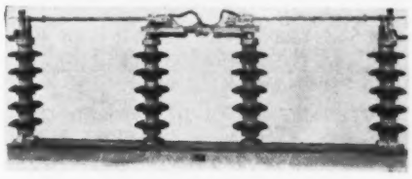
An ever-recurring difficulty with European tariff policies from the American point of view is the suddenness and frequency of their changes. Tariff alterations are admittedly troublesome and upsetting whenever they occur. But in the case of the United States there is at least the merit of a relative infrequency of such a "plague." Throughout Europe, on the other hand, tariff policies are in constant process of alteration, since in most cases they can be changed through ministerial decree and do not require any parliamentary discussion.

New Equipment Available

Double-Blade Selector

A double-blade selector unit which is a single-pole element of a gang-operated three-pole switch for hand or motor operation, designated DMA-39, is announced by the Delta-Star Electric Company, Chicago. The middle insulators are mounted on ball bearings, insuring easy operation.

The outside insulators carry full floating contacts with blade guides and shock absorbers to minimize shocks or jars during fast-closing operation. The heavy-duty tubular copper blade with arcing tips is locked in closed position. When opening, the blade first with-



draws horizontally and then raises to full open position. As the blade withdraws from the lock and floating contact it compresses the spring, which then serves to accelerate the blade movement, materially increasing its speed. These switches, simple in construction, use a minimum number of insulators and are made for all voltages from 7.5 kv. to 110 kv.

Solderless Clamp Type Internal Pothead Terminal

A new solderless clamp type internal terminal for potheads which greatly facilitates pothead installations and lowers installation costs is announced by the Line Material Company, South Milwaukee, Wis. The capnut is threaded and is provided with a nut for fastening the cable terminal lug. The capnut completely covers the end of the cable and conical contact sleeve. The terminal is made watertight as the capnut is threaded down over the pothead cemented cap.

Making a connection to this type of pothead terminal is comparatively a simple matter—the conductor is passed through the bushing with capnut and sleeve seat removed. The conductor is marked at the top of the cementing cap of the bushing and at a point ¼ in. higher than the contact sleeve above the cementing cap. The conductor is cut off and insulation removed to a point ¼ in. below the lower marking. The sleeve seat is then replaced over the cementing cap with contact sleeve immediately above. The capnut, with its inside conical milled surface, is then screwed down over the split conical contact sleeve, which is forced in tightly against the bare cable, thus forming a very high-pressure contact.

This type of terminal has proved very satisfactory, according to the manufacturer, and is recommended for use on all Line Material Company's standard outdoor potheads where a solderless clamp type terminal is desired.

Dust-tight and Weatherproof Line Starters

A new line of dust-tight and weatherproof line starters is announced by the Westinghouse Electric & Manufacturing Company. They are remote controlled, non-reversing, across-the-line type magnetic starters for single-phase, polyphase, squirrel-cage induction motors. These starters are recommended by the manufacturer especially where dust-tight starters are desired.

One new feature is that in the cabinet construction a cast-iron cabinet is used with a gasket seal on the door. The conduit is brought in through the top and bottom in threaded openings, so as to make a dust-tight connection. They are equipped with the "deion" grid type arc quencher. It not only provides for the highest degree of protection against flash-overs even under severe operating conditions, but it also increases the life of the contacts.

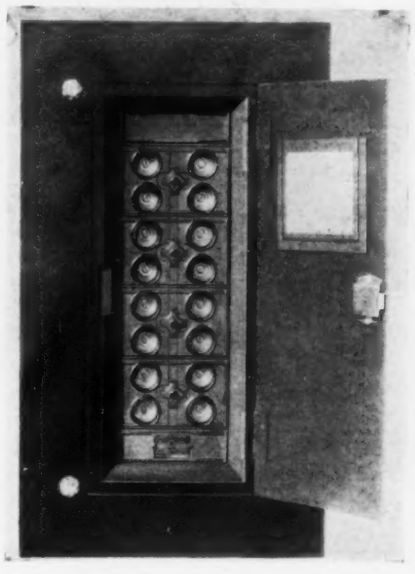
To prevent the operator from breaking the seal whenever the motor is put back in service after an overload, the two small size line starters are equipped with an automatic reset thermal overload relay. This relay has interchangeable heaters and accessible calibration lever and quick make-and-break contacts. The new line starter is available in three sizes up to 50 hp.

A NEW PLANER-MATCHER that will plane 42½ lineal miles of ordinary flooring in seven hours is announced by the Stedson-Ross Machine Company, Seattle, Wash. This machine, model 6-16-A1, weighs 45,000 lb. and is powered by thirteen individual Westinghouse motors. The motors are built directly into the cutting machine and furnish power direct without transmission. The push-button systems of automatic control were designed, built and assembled in the Seattle service shop of the Westinghouse Electric & Manufacturing Company.

SWITCH APPLIANCE PLUG FITS ANY APPLIANCE. — A new Hemco switch appliance plug, H-260, has been placed on the market by the Bryant Electric Company of Bridgeport, Conn. This plug has an exceptionally reliable switch, according to the manufacturer, and fits almost any type of appliance. It is made of molded bakelite with strain relief grooves where the cord enters the plug. The terminals are self-aligning and automatically adjust themselves to perfect contact over either round or flat terminal lugs. A self-aligning feature is due to the fact that one side of the terminal is secured in a floating position. The terminals are brass and the contact spring is made of a special heat-treated piano wire.

Narrow Lighting Panelboards

A full line of new narrow lighting panelboards is announced by the Square D Company, Detroit, manufacturer of electrical control equipment. The boards are only 12 in. wide over all and may be used in places where larger panelboards cannot conveniently be installed. For industrial or domestic use they meet the requirements up to



100-amp. capacity and are made complete with all copper busbars of standard capacity. They can be supplied with cartridge fuses as well as plug fuses. Switched circuits as well as fuses only can be supplied in the branches.

There are six different wiring combinations possible with the Square D narrow panelboards. They have also molded parts of genuine bakelite, durable and serviceable. Spring-catch locks are standard equipment and where both switches and fuses are supplied the switches are of the tumbler type, heavy duty, 30-amp., 250-volt rating, the same as used in the standard panelboard.

A NEW LINCOLN STABLE ARC WELDER mounted on a McCormick-Deering tractor is announced by the Pontiac Tractor Company, Pontiac, Mich. It is furnished in either the 200- or 300-amp. machine. The extension frame is such that the tractor is simply set into a 4-in. I-beam frame and the front axle assembly is set ahead under the frame, thereby lengthening the wheelbase. The welder unit complete with the panel is mounted on this frame member ahead of the tractor and takes its drive from the power pulley at the side of the tractor by a belt. The 48x4 dual tire used in the rear gives this unit a road speed of 15 m.p.h.

Electrical Patents

Announced by U. S. Patent Office

(Issued September 3, 1929)

1,726,389. FUSE PLUG; A. C. Engelhardt, Memphis, Tenn. App. filed June 8, 1925.

1,726,391. ELECTROMAGNETIC OPERATING MEANS; R. W. Goff, Schenectady, N. Y. App. filed Aug. 31, 1925.

1,726,392. ELECTRIC SWITCH; R. W. Goff, Schenectady, N. Y. App. filed July 9, 1926.

1,726,397. ENGINE STARTER; R. P. Lansing, Montclair, N. J. App. filed Jan. 27, 1926.

1,726,426. LIQUID CONTACT SWITCH; A. M. Distell, Olten, Switzerland. App. filed Dec. 22, 1926.

1,726,427. ELECTRICALLY-HEATED HAND-TOOL SWITCH; G. Eaton, Baltimore, Md. App. filed April 27, 1926.

1,726,428. SWITCH FOR ELECTRICALLY-HEATED HAND TOOLS; G. Eaton, Baltimore, Md. App. filed April 27, 1926.

1,726,476. RESISTANCE ELEMENT; R. R. Dunlop, Columbus, O. App. filed March 8, 1924.

1,726,492. FUSE PROTECTOR; A. Kantor, Edmonton, Alberta, Can. App. filed Jan. 9, 1925.

1,726,503. THERMAL CUT-OUT; C. D. Platt, Bridgeport, Conn. App. filed Aug. 9, 1926.

(Issued September 10, 1929)

1,727,328. HIGH-FREQUENCY MEASURING SYSTEM; H. A. Affel, Ridgewood, N. J. App. filed Nov. 21, 1924.

1,727,331. PROCESS OF COATING ALUMINUM ELECTROLYTICALLY; C. L. Beal, Rochester, N. Y. App. filed Jan. 17, 1927.

1,727,344. CURRENT-FLOW-REGULATING MEANS; M. J. Huggins, Upper Saddle River, N. J. App. filed Feb. 3, 1925.

1,727,347. ELECTRICAL PLUG CONNECTION; E. Knickerbocker, Moline, Kan. App. filed July 5, 1927.

1,727,361. ARC LIGHT; E. G. Ashcraft, Los Angeles, Calif. App. filed Nov. 19, 1926.

1,727,368. HOLDING MEANS FOR ELECTRIC FIXTURES; A. L. Eustice, Chicago, Ill. App. filed May 10, 1922.

1,727,381. BATTERY-CHARGING SYSTEM; M. Schwartz, Chicago, Ill. App. filed July 10, 1926.

1,727,387. SAFETY CONNECTION FOR HIGH-TENSION CABLES; F. Zogbaum, New Rochelle, N. Y. App. filed March 24, 1927.

1,727,421. ELECTRICAL APPARATUS; W. E. Wendt, Dayton, O. App. filed Oct. 31, 1927.

1,727,422. DIRECTION-INDICATOR SWITCH FOR MOTOR VEHICLES; M. C. Westfall, C. W. Klauberg and R. B. Foster, Columbus, O. App. filed April 28, 1926.

1,727,459. CORE FOR ELECTRIC WATER HEATERS; G. F. Webb, Hamilton, Ont., Can. App. filed Feb. 29, 1928.

1,727,462. SOLUTION FOR CHEMICAL RECTIFIERS; F. T. Bowditch, Elmhurst, N. Y. App. filed June 21, 1924.

1,727,494. RECORDING GALVANOMETER; F. F. Uehling, Passaic, N. J. App. filed Jan. 27, 1927.

1,727,509. APPARATUS FOR CONTROLLING THE REGISTRATION CURVE OF ELECTRIC METERS; F. Kurz and R. Wilmeth, Springfield, Ill. App. filed Dec. 21, 1925.

1,727,522. SIGNAL LIGHT; W. Schlie, Chicago, Ill. App. filed Jan. 14, 1924.

1,727,532. SPARK PLUG; E. A. Barnett, Port Arthur, Tex. App. filed Dec. 4, 1924.

1,727,552. ELECTRIC CELL; C. W. Marsh, Greenwich, Conn. App. filed Nov. 6, 1919.

1,727,553. LIFTING MAGNET; P. J. McCullough, St. Louis, Mo. App. filed Jan. 15, 1927.

1,727,564. HEATING UNIT; W. A. Salisbury, Seattle, Wash. App. filed Nov. 4, 1926.

1,727,581. FIXED CONDENSER; S. J. Wood and H. A. Greene, Jr., Los Angeles, Calif. App. filed Dec. 23, 1925.

1,727,573. ELECTRIC HEATER; H. J. Tietz, San Pedro, Calif. App. filed Feb. 10, 1928.

1,727,584. HIGH-TEMPERATURE FLUID-HEATING APPARATUS; R. A. Carleton, Newton Center, Mass. App. filed Aug. 23, 1927.

1,727,585. FLUID HEATING AND VAPORIZING APPARATUS; R. A. Carleton, Newton Center, Mass. App. filed Aug. 23, 1927.

1,727,631. ELECTRIC SWITCH; G. Bruhlmann, Collingswood, N. J. App. filed May 9, 1927.

1,727,656. RECTIFIER COMPOUND; F. H. Mackenzie, Philadelphia, Pa. App. filed April 12, 1926.

1,727,676. CONTROL SWITCH; J. P. Salfer, Mankato, Minn. App. filed Dec. 22, 1928.

1,727,762. SHEATHED ELECTRICAL CONDUCTOR; O. A. Frederickson, Wethersfield, Conn. App. filed Feb. 25, 1926.

1,727,733. APPARATUS FOR ELECTROLYTIC AND SIMILAR TREATMENTS; F. T. Taylor, Matawan, N. J. App. filed Sept. 23, 1925.

1,727,766. CRADLE MOTOR; F. J. Haburcak, Cleveland, O. App. filed Sept. 22, 1926.

1,727,767. ENCLOSED SWITCH CONSTRUCTION; H. J. Hammerly, Wallingford, Conn. App. filed Oct. 8, 1928.

1,727,772. JOINT FOR LIGHTING SYSTEMS; P. M. Hotchkin, Chicago, Ill. App. filed May 3, 1926.

1,727,793. STARTER FOR AUTOMOBILES; W. C. Starkey, Indianapolis, Ind. App. filed May 16, 1925.

1,727,814. MOVABLE ELECTRIC CONDUCTOR AND CLAMP; C. S. Davis, Pasco, Wash. App. filed Feb. 20, 1928.

1,727,826. FILAMENT TUBE; M. Harris, New Rochelle, N. Y. App. filed April 5, 1926.

1,727,834. RECTIFYING SYSTEM; J. Kubler, Baden, Switzerland. App. filed April 30, 1921.

1,727,842. ELECTRIC CHAMBER; E. Stallworth, Americus, Ga. App. filed Sept. 12, 1927.

1,727,848. IGNITION DEVICE; L. R. Wilder, New York, N. Y. App. filed April 29, 1926.

1,727,849. VACUUM CLEANER; W. J. Wise and T. O. Adams, New Philadelphia, Ohio. App. filed May 19, 1923.

1,727,854. DIRECTION SIGNAL; L. Beaumon, Hollywood, Los Angeles, Calif. App. filed March 4, 1927.

1,727,858. MEANS FOR METERING ALTERNATING CURRENTS; W. Beusch, Zug, Switzerland. App. filed Feb. 17, 1926.

1,727,872. MOTOR CONTROLLER; C. T. Evans, Wauwatosa, Wis. App. filed Aug. 11, 1923.

1,727,881. ELECTRIC LIQUID HEATER; R. C. Hoyt, Oakland, Calif. App. filed June 22, 1927.

1,727,887. STORAGE BATTERY; R. A. Klock, Closter, N. J. App. filed May 24, 1924.

1,727,899. VAPORIZING DEVICE; W. H. Odlum, Chicago, Ill. App. filed May 10, 1928.

1,727,913. ELECTRIC HEATING ELEMENT FOR HOT WATER BOTTLES; A. Svenn and A. Soderholm, Chicago, Ill. App. filed June 9, 1928.

1,727,917. BRUSH MOUNTING; A. Zerbo, Detroit, Mich. App. filed March 12, 1927.

1,727,930. SAFETY DEVICE PROVIDED WITH CELLS WHICH ARE SENSITIVE TO LIGHT; E. H. Bock, Hamburg, Germany. App. filed March 13, 1924.

1,727,932. RADIOCOIL; N. Medved, Canton, O. App. filed April 6, 1926.

1,727,949. REDUCING THE EFFECTS OF RESIDUAL MAGNETISM IN ELECTRICAL APPARATUS; H. L. Tanner, Brooklyn, N. Y. App. filed Nov. 28, 1924.

1,727,955. ELECTRICAL CABLE; J. H. Biggar, Oak Park, Ill. App. filed Oct. 22, 1924.

1,727,957. LIGHTING AND IGNITION SWITCH; E. A. Bohlman, Chicago, Ill. App. filed March 9, 1925.

1,727,959. ELECTRICAL HEATING UNIT; K. H. Bowen, Auburn, N. Y. App. filed Jan. 2, 1929.

1,727,963. ELECTROLYTIC RECTIFIER; C. C. Carpenter, East Cleveland, O. App. filed July 15, 1922.

1,727,968. ELECTROMAGNETIC RELAY; J. Erickson, Chicago, Ill. App. filed Dec. 31, 1919.

1,727,971. ELECTRICAL CABLE; L. S. Ford, River Forest, Ill. App. filed Nov. 30, 1923.

1,727,972. ELECTRICAL CABLE; L. S. Ford, River Forest, Ill. App. filed April 18, 1924.

1,727,983. ELECTRIC HEATER; H. D. Jermon, Gloucester, N. J. App. filed June 1, 1928.

1,727,986. WELDER'S TONGS; W. W. Jones, Jr., Los Angeles, Calif. App. filed Aug. 26, 1927.

1,727,989. ELECTRIC DISTRIBUTION SYSTEM; L. F. Kennedy, Schenectady, N. Y. App. filed Feb. 14, 1928.

1,728,003. STROBOSCOPE; C. A. Nickle, Schenectady, N. Y. App. filed May 19, 1927.

1,728,004. RHEOSTAT; M. L. Norris, Fort Wayne, Ind. App. filed March 31, 1926.

1,728,012. THERMOSTATIC DEVICE; J. J. Simmons and R. J. Delaney, Philadelphia, Pa. App. filed June 18, 1928.

1,728,013. CONVENIENCE OUTLET RECEPTACLE; H. E. Slade, Newark, and J. B. Downing, East Orange, N. J. App. filed May 4, 1925.

1,728,019. CONVERTIBLE SWITCH; G. R. Townsend, Schenectady, N. Y. App. filed July 1, 1927.

1,728,020. ELECTRIC SWITCH; O. C. Traver, Schenectady, N. Y. App. filed Jan. 16, 1924.

1,728,024. PROTECTIVE ARRANGEMENT; A. von Schaubert, Berlin, Germany. App. filed April 17, 1928.

1,728,028. VARIOMETER; P. D. Andrews, Schenectady, N. Y. App. filed April 7, 1928.

New Trade Literature

PIPE FITTINGS. — Delta-Star Electric Company has issued Bulletin No. 70, entitled "Standardized Uniclamp Pipe Fittings." This booklet, containing 36 pages, has a plentiful supply of illustrations showing the various combinations of "Uniclamp" pipe fittings. The fact is brought out forcibly, both in the text and illustrations, that from five parts innumerable combinations can be made.

WATER WHEELS.—Particular features of the hydro-electric installation at Middleport, N. Y., for the Buffalo, Niagara & Eastern Power Corporation are described in Bulletin W206, just issued by James Leffel & Company, Springfield, Ohio. The booklet contains illustrations and gives many interesting construction details.

AUXILIARY POWER AND LIGHTING EQUIPMENT.—The Westinghouse Electric & Manufacturing Company is distributing pamphlet DMF-5182, entitled Modern Auxiliary Power and Lighting Equipment." It describes the newest class of Westinghouse turbo-generator equipment for supplying auxiliary power for lighting and other purposes on shipboard. Besides general descriptive material the folder contains approximate dimensions and weights of the units and a general description on heat balance arrangement. The leaflet is illustrated with several photographs of different sizes of turbo-generator units.

AMMETERS. — The Roller-Smith Company, New York City, announces a new issue of its Bulletin No. 810, covering its types TW, FW and STW thermocouple ammeters and milli-ammeters for direct current and alternating current of all frequencies, including radio frequencies. The types TW (3½ in.) and FW (4 in.) cover a range of 100 milli-amperes to 20 amp. and the type STW (7½ in.) from 10 to 100 amp. These instruments incorporate a new and improved form of thermocouple, which is distinguished by very high overload capacity and sustained accuracy over a wide range of temperature.

Foreign Trade Opportunities

Following are listed opportunities to enter foreign markets. Where the item is numbered, further information can be obtained from the Bureau of Foreign and Domestic Commerce, Washington, by mentioning the number:

Purchase and agency are sought in Turin, Italy (No. 40,878), for storage batteries.

Purchase is sought in Ponta Delgada, Azores (No. 40,880), for electrical branding machines, wooden case.

Purchase is desired in Panama City, Panama (No. 40,909), for electric clocks.

Agency is desired in Montreal, Canada (No. 40,962), for electric fixtures.

Agency is sought in Johannesburg, South Africa (No. 40,877), for flashlights and batteries.

Purchase is desired in Berlin, Germany (No. 40,996), for multiple plug fuses.

Purchase is desired in Ceska Lipa, Czechoslovakia (No. 40,879), for household electrical appliances.

Agency is desired in Berlin, Germany (No. 40,882), for household electrical appliances.

Purchase is sought in Copenhagen, Denmark (No. 40,994), for electrical lamps with dynamos for bicycles.

Agency is desired in Taihoku, Japan (No. 40,876), for farm lighting plants.

Purchase is sought in Panama City, Panama (No. 40,909), for motors, lights, telephones and annunciators.

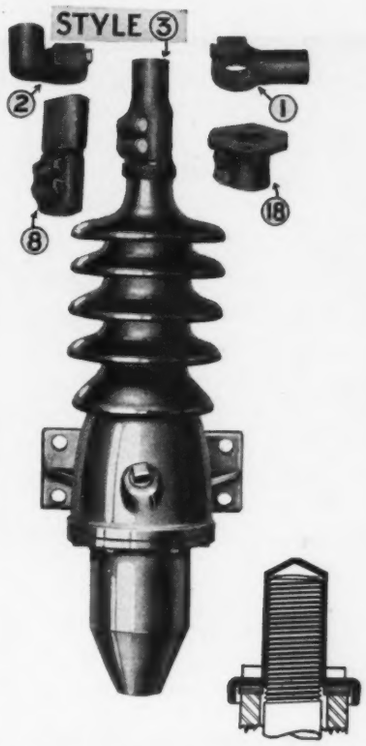
Purchase or agency is sought in Regina, Canada (No. 40,881), for pole line material, such as insulators and anchors.

Purchase is desired in The Hague, Netherlands (No. 40,995), for radio parts.

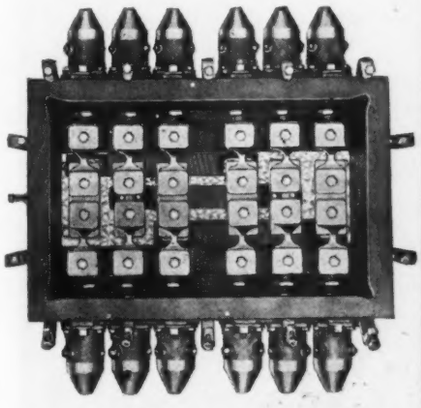
Agency and purchase are desired in Buenos Aires, Argentina (No. 40,993), for radio sets and parts and loud speakers.

Agency is desired in Warsaw, Poland (No. 40,883), for radio technical equipment.

Purchase is sought in Berlin, Germany (No. 40,992), for insulating wire and cables for automobiles.



The hood nut on the G & W Type T pothead has a complete watershed. No exposed threads to cause water leakage. Furnished in all voltages and for all cables. Five standard aerial lugs to fit every hood nut.



The AF Box is for heavy currents at 600 volts maximum. Made for open link fuses. Each cable compounded separately and is a unit right up to bus. Cables can be added or removed without disturbing rest of box. Type AL box has solid disconnecting links—otherwise same as "AF" box.

WHETHER the energy comes from out of the man-hole or from off the pole top —its continuity is efficiently and economically protected by

G&W equipment

G & W equipment is not costly, particularly considering the huge investments it efficiently, economically, and fully serves. When trouble arises on the lines, it is then that the full value and importance of G & W equipment is realized. Refer to our Catalog No. 27 regarding any of your overhead or underground problems. Also a G & W Engineer will gladly assist you.

G & W ELECTRIC SPECIALTY CO.

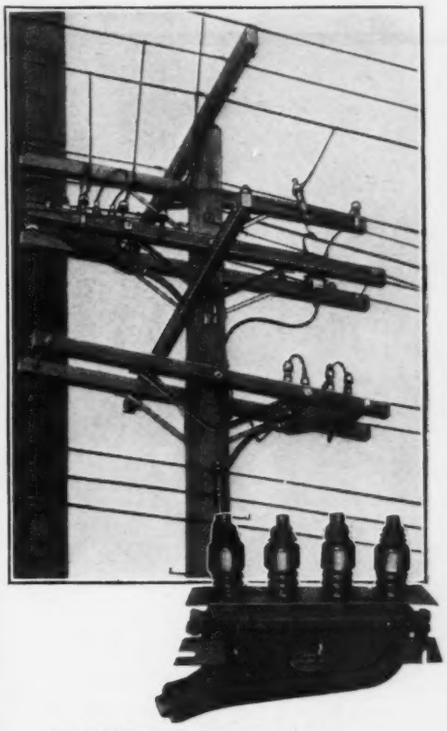
7780 Dante Ave., Chicago

G&W ELECTRIC SPECIALTIES

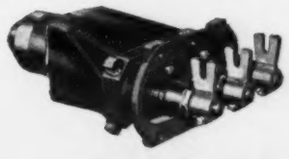
Exactly What You Want

G & W designs and manufactures practically every device for the end of a cable. See our Catalog No. 27.

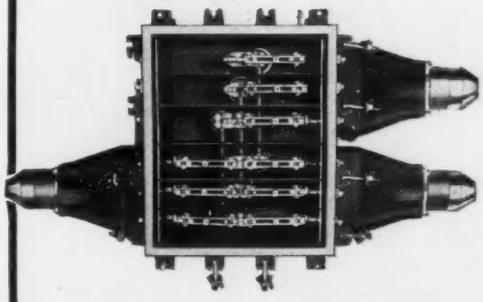
Potheads
Series Cutouts
Primary Cutouts
Underground Boxes
H&T Insulating Sleeves
Conduit Bells
Ground Pipe Caps
Ground Pipe Points
"Oil and air break" disconnecting devices with and without automatic control
Vault Unit
Oil Disconnect



G & W disconnecting potheads are sectionalizing points. Four types of cable entrances are optional. Easily compounded. Many shapes to fit installation conditions.



UNIT CABLE HEAD

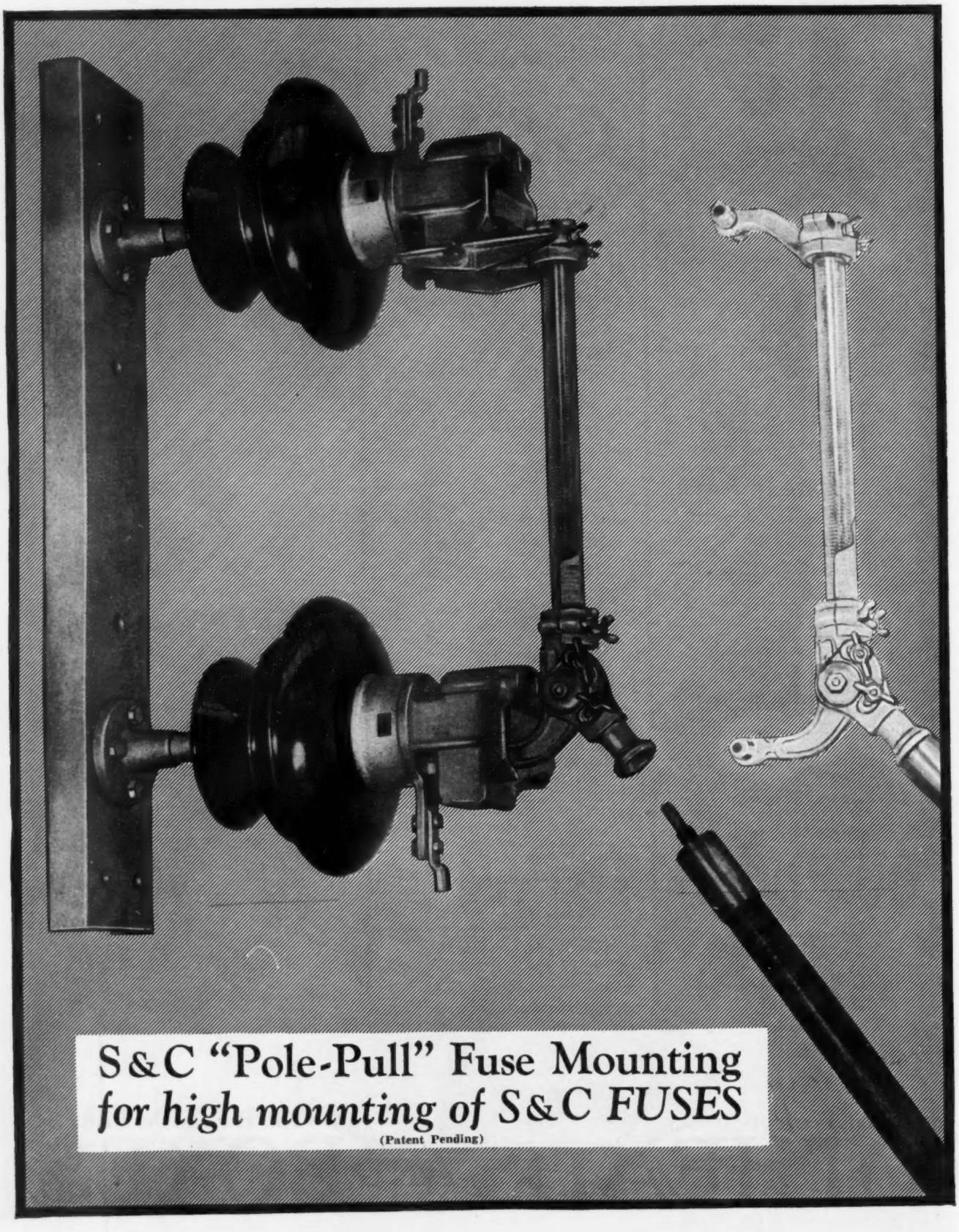


The Type H box is for 4,500 volt operation. Has solid disconnecting links. Each cable a unit right to bus. Made in from two to eight ways for two, three, or four conductors up to 1,000 amperes. An ideal box for sectionalizing the primary in manholes or vaults.

More than Protection **G&W** for the Cable Ends

POTHEADS AND BOXES

Improve the service and



reduce operating costs

by using

S&C Fuses and S&C Fuse Mountings

The S&C Fuse improves the service and reduces operating costs because it is dependable. This dependability is the result of high interrupting capacity together with uniformity in manufacturing, refilling, and rating.

S&C Fuse Mountings aid materially in service improvement and operating cost reduction by having the proper mechanical strength throughout for the support of the S&C Fuse during fuse operation on short-circuit.

These mountings have superior contact clips which provide a good contact and allow easy replacement of fuses; also, they are designed with a proper regard for normal as well as abnormal voltage stresses related to fuse operation.

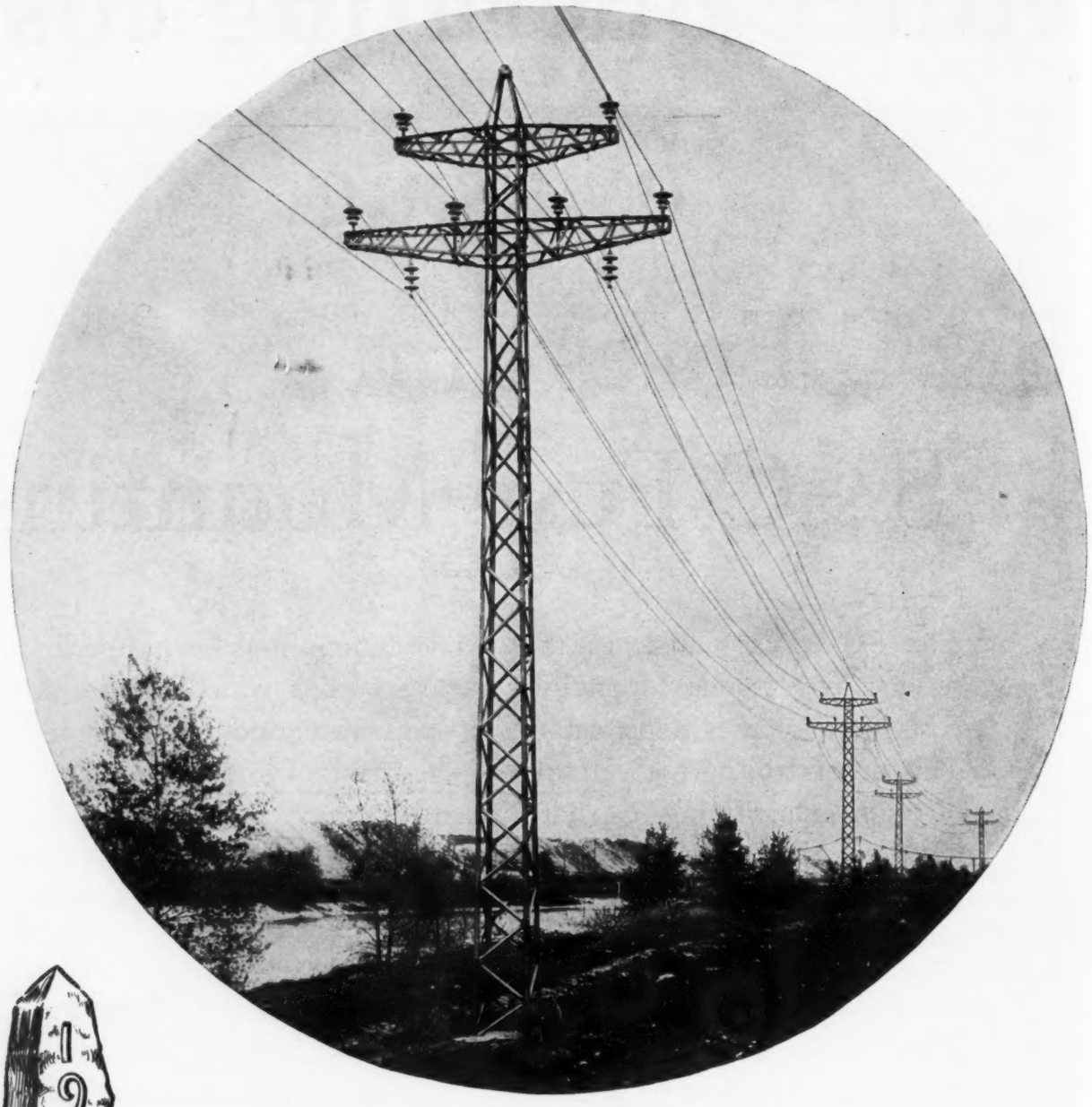
Therefore when S&C Fuses are used in S&C Fuse Mountings the two work together as a unit and the result is a dependable fuse protection which improves the service and reduces operating costs.

SCHWEITZER S AND C CONRAD, INC.

4435 RAVENSWOOD AVENUE CHICAGO, ILLINOIS U.S.A.

Trade Mark Reg. U. S. Pat. Off.

THE TWENTY-YEAR STORY



1911---The Third Milestone

The 44,000-volt transmission line of the Sanitary District of Chicago, running along the Drainage Canal from Chicago to Lockport. The O-B suspension insulators were installed in 1911.

This is the third of a series of advertisements telling the 20-year story of O-B insulator development.

Y OF INSULATOR DEVELOPMENT

Milestones of Transmission Line Construction

TRANSMISSION facilities of the Sanitary District of Chicago, in 1911, were not sufficient to take care of the growing load placed on its lines by the extension of Chicago's boulevard lighting system, and by the other growing power requirements served.

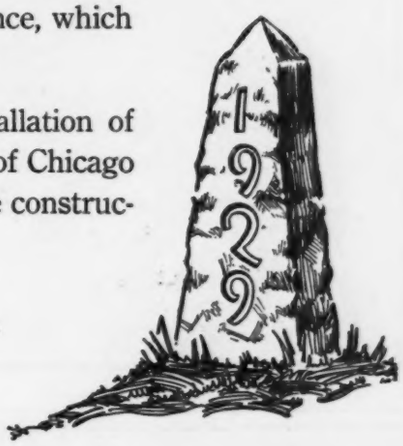
So additional transmission facilities were planned to carry power from the Lockport power house, 30 miles below Chicago, to the substation at Western Avenue and the Drainage Canal.

Recognizing the successful experience of others in the use of O-B cap and pin suspension insulators, the Trustees of the Sanitary District investigated and selected O-B insulators for use in strings of three 10-inch units to insulate their new 44,000-volt line.

Certain changes in design were made at this time to provide for new service conditions. The spacing between units was reduced, thus permitting more insulation to be packed into a given string length. This important fundamental change was responsible for the design of O-B Insulator No. 25622, of which millions are now in service.

More of these short spaced units can be put in a string of given length, thereby providing more effective insulation. Among other things, efficient use of string length makes better use of tower clearance, which is an item on a transmission line.

Thus, because it marks this important design change, the installation of O-B suspension insulators on the lines of the Sanitary District of Chicago added another milestone in the progress of transmission line construction and insulation.



Ohio Brass Company, Mansfield, Ohio
Canadian Ohio Brass Co., Limited
Niagara Falls, Canada
1119H

Ohio Brass Co.
NEW YORK PITTSBURGH PHILADELPHIA BOSTON
CHICAGO CLEVELAND ST. LOUIS ATLANTA SAN FRANCISCO LOS ANGELES DALLAS
PORCELAIN INSULATORS
LINE MATERIALS
RAIL BONDS
CAR EQUIPMENT
MINING MATERIALS
VALVES

Protection for

To ..cut operating costs..

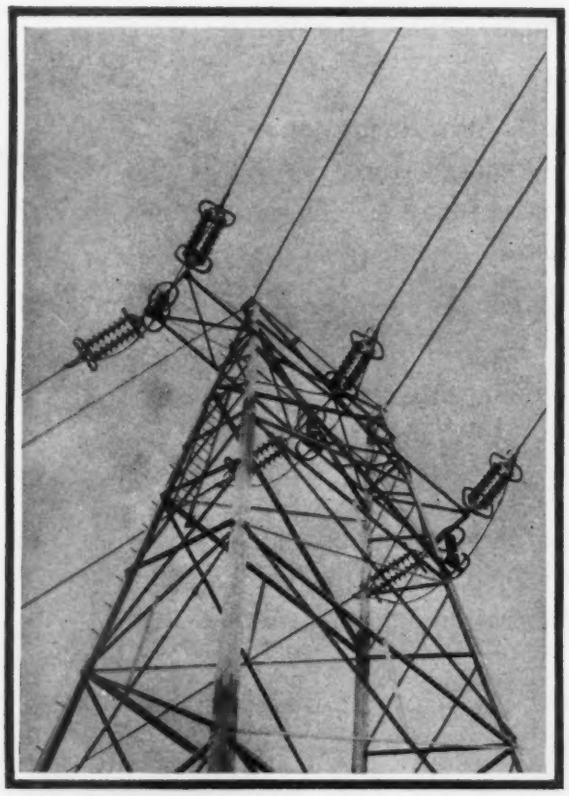
..decrease outages..

..decrease time taken to resume service after outage..

..decrease damage to insulators or conductor..

..increase the flashover values of your line insulation..

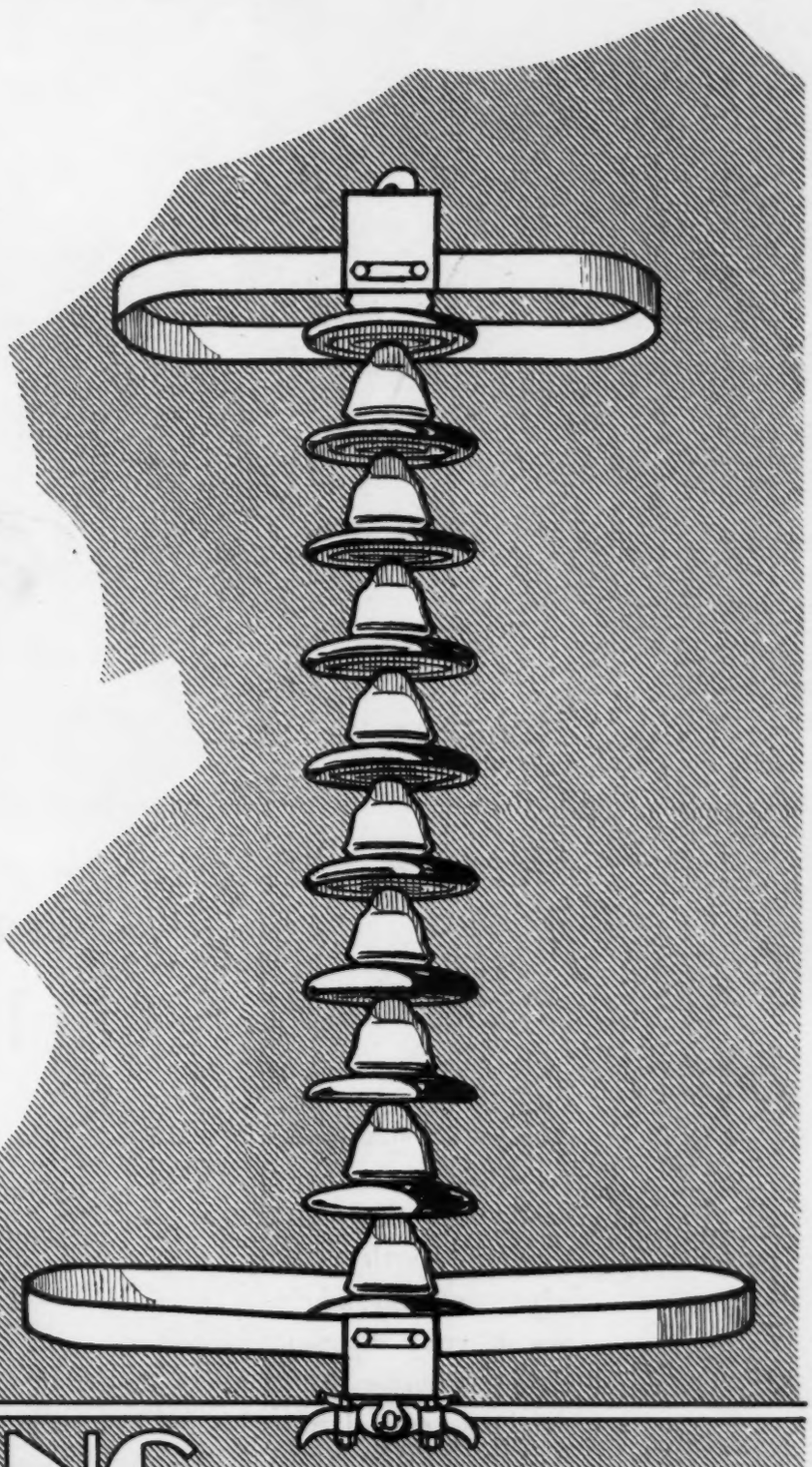
..improve service to your customers..



YOU NEED

LOCKE

your lines



Any Locke Representative will be pleased to give you the fullest information on Locke Grading Shields.

LOCKE R=∞

GRADING SHIELDS

Here Science helps you, too!

The same standards of trained accuracy and scientifically governed procedure which are winning for Bartlett general preference in our large private practice are at your disposal. Interference trimming by Bartlett dedricians, trained and schooled in the traditions of the famous Bartlett Tree Research Laboratories, is both an investment in good will and an immediate economy in maintenance costs. Results such as these prove the safety and the economy of the Bartlett Way. For information write or wire.

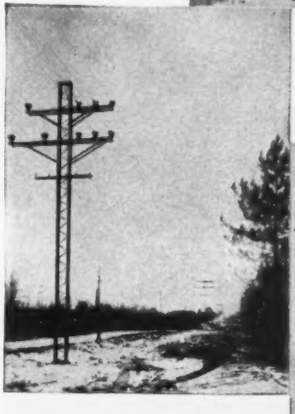
Public Utilities Division

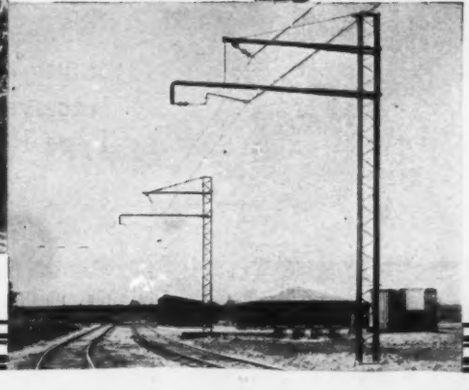
The F. A. BARTLETT TREE EXPERT COMPANY

STAMFORD, CONN.

WELTRUS STEEL POLES

SOLVE OVERHEAD CONSTRUCTION PROBLEMS



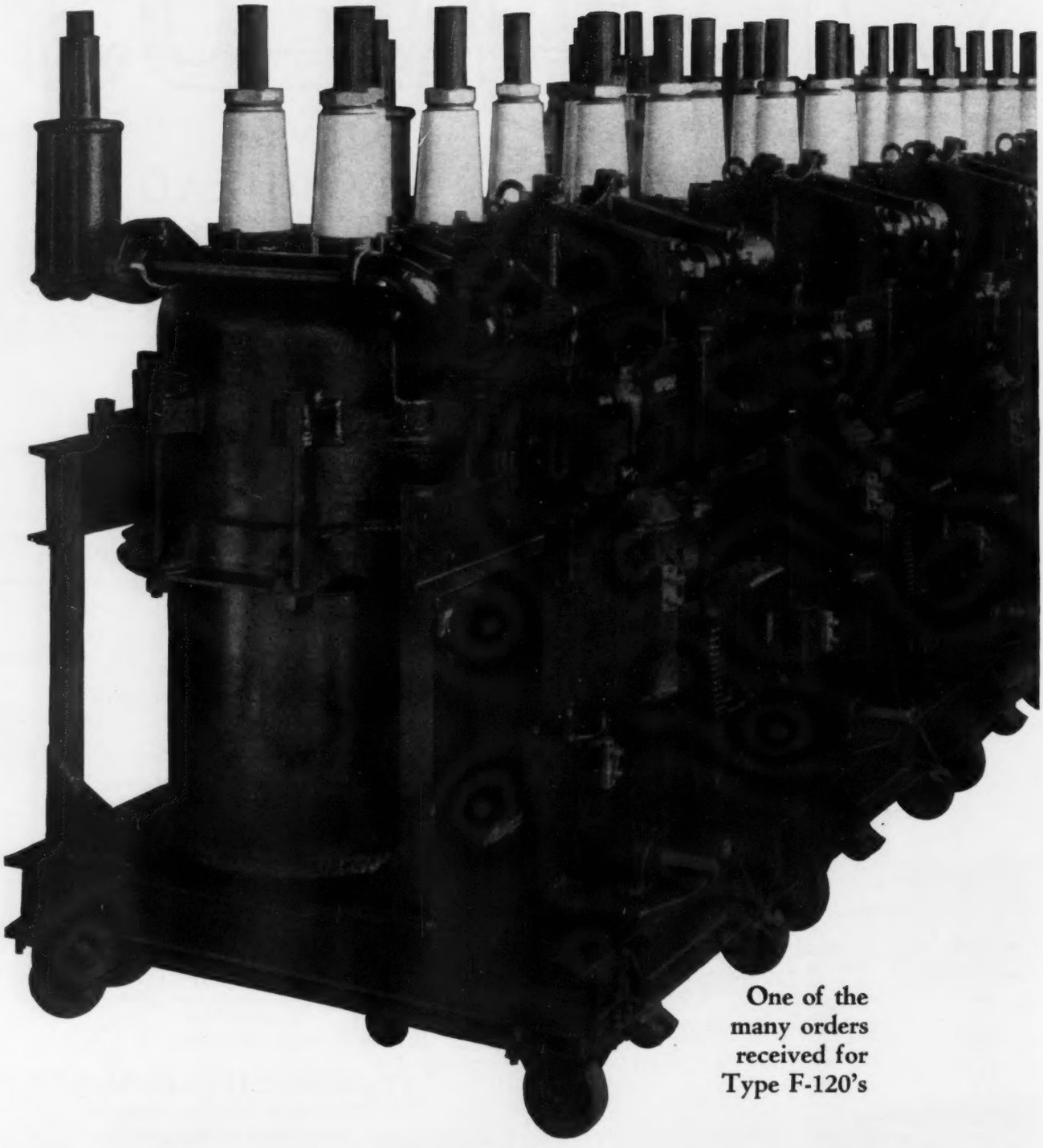


The sturdy, trim Weltrus Steel Poles are typically in keeping with modern electrical development, and their all-around utility is shown by the great diversity of uses to which they are put. Combination street lighting and distribution lines, combination trolley and distribution lines, high tension transmission lines, high speed interurban trolley lines, pipe supports—in fact, overhead construction of any kind is done better and more economically with Weltrus Steel Poles. The cost is not only within the reach of any project soundly conceived and conservatively financed, but is directly comparative with the cost of hazardous and temporary forms of construction.

A comparison of the physical properties and load ratings of Weltrus Poles with other poles of equivalent weight will conclusively demonstrate the efficiency of their design.

TRUSCON STEEL COMPANY
Transmission Structures Department
YOUNGSTOWN, OHIO

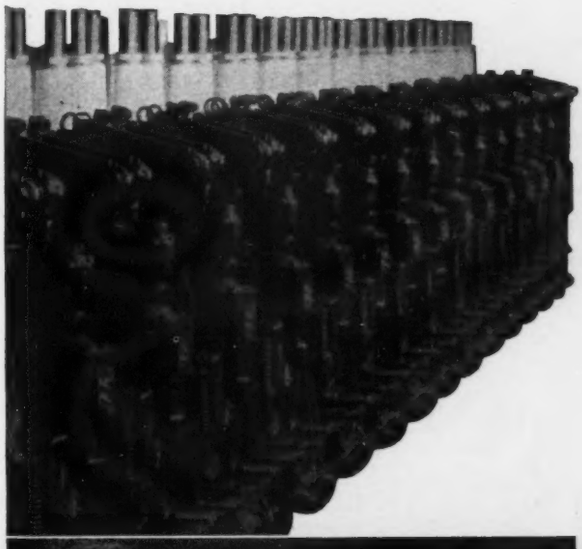
GOING TO

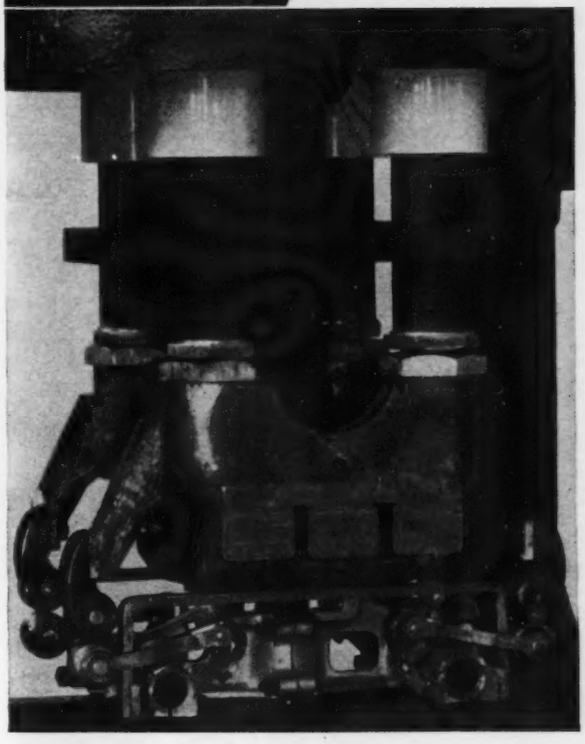


One of the many orders received for Type F-120's

ONDIT

WORK —





This regiment of Condit Breakers will mean Improved Service for One Super-Power System. Why not yours?

Type F-120-15D.
3,000 Amperes.
15,000 Volts.
1,000,000 Kv-a
interrupting capacity.

Condit design and Condit craftsmanship give this breaker important electrical and mechanical advantages.

It merits your consideration for heavy duty indoor installations.

"*Get in touch with Condit*"

CONDIT ELECTRICAL MFG. CORPORATION
Manufacturers of Electrical Protective Devices
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Distributor for the Dominion of Canada

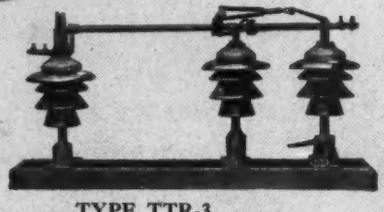
CONDIT

3280

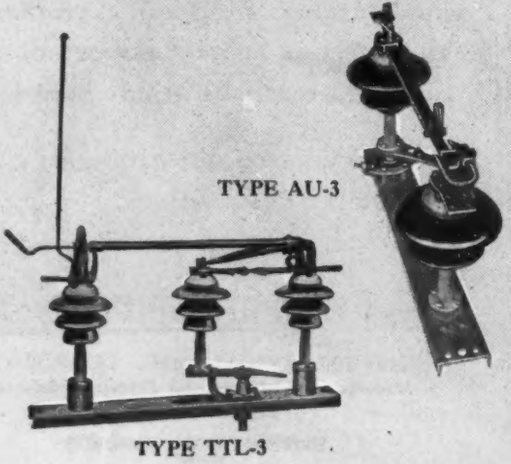
HI-PRESSURE CON-
AIR-BREAK AND DISCONNECTING

Also famous for refinement

LITTLE refinements that you don't ordinarily look for—or haven't been accustomed to getting . . . but when they are called to your attention . . . or you yourself discover them . . . you appreciate that there is a margin of



TYPE TTR-3



TYPE AU-3

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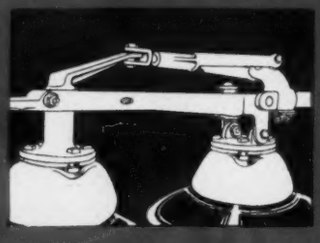
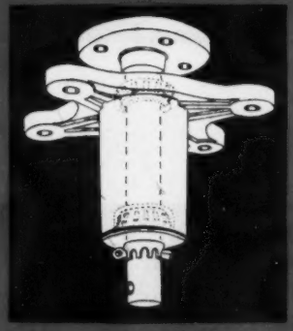


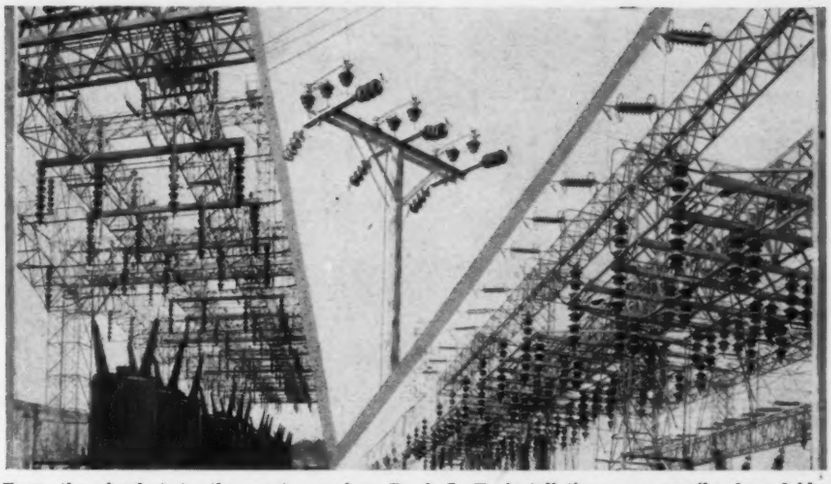
Non-corrosive weather resisting high strength metals for operating parts.

Bearings as efficient as you find in any automobile.



Look it up FIRST in the R. & I. E. catalog.

TACT SWITCHES



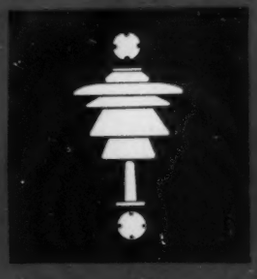
From the simplest to the most complex—R. & I. E. installations are equally dependable. R. & I. E. experience is also universal in application and world-wide in scope.

of details

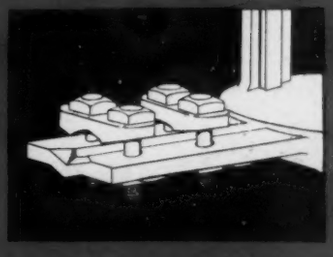
quality that is the distinguishing mark of R. & I. E. equipment.

Investment in R. & I. E. equipment cannot be termed a "cheap" investment . . . for it is neither cheap in appearance nor built to a price. The very fact that it "does more" makes it worth more to you. You owe it to those who look to you for service to install nothing less rugged—nothing less dependable than R. & I. E. equipment.

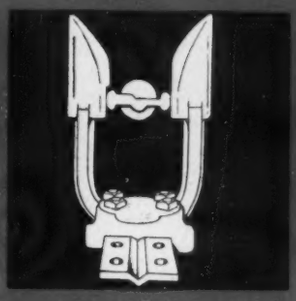
Insulator units that are interchangeable for any position on the switch.

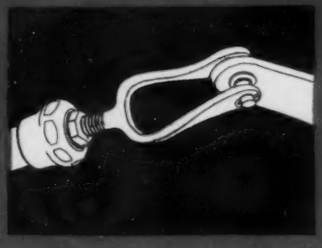


Clamp type copper terminals with four one-half inch bolts for conductor sizes up to and including one inch I. P. S. A quick, permanent, one-man connection.



HI-PRESSURE contacts that are self-cleaning with every operation of the switch. AN EXCLUSIVE R. & I. E. FEATURE.





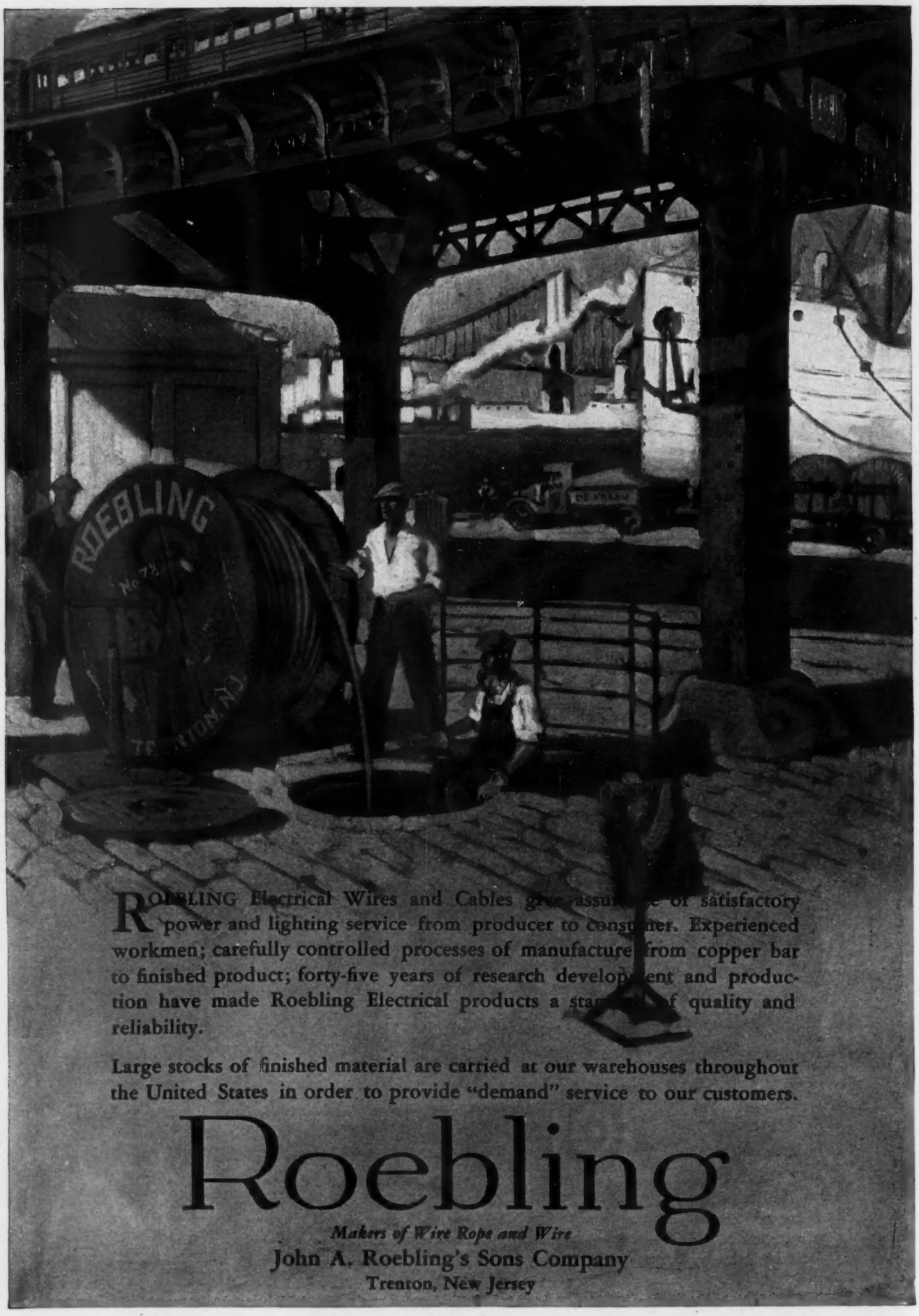
Drop forged clevises, malleable couplings—light, strong, easily

Representatives in

Boston
New York
Philadelphia
Pittsburgh
Buffalo
Cleveland
Chicago
Cincinnati
St. Louis
Denver
Charlotte

Birmingham
Dallas
Indianapolis
Kansas City
Los Angeles
Minneapolis
San Francisco
Seattle
Toronto
Phoenix

RAILWAY AND INDUSTRIAL ENGINEERING CO. . . . . GREENSBURG, PA.



ROEBLING Electrical Wires and Cables give assurance of satisfactory power and lighting service from producer to consumer. Experienced workmen; carefully controlled processes of manufacture from copper bar to finished product; forty-five years of research development and production have made Roebling Electrical products a standard of quality and reliability.

Large stocks of finished material are carried at our warehouses throughout the United States in order to provide "demand" service to our customers.

Roebling

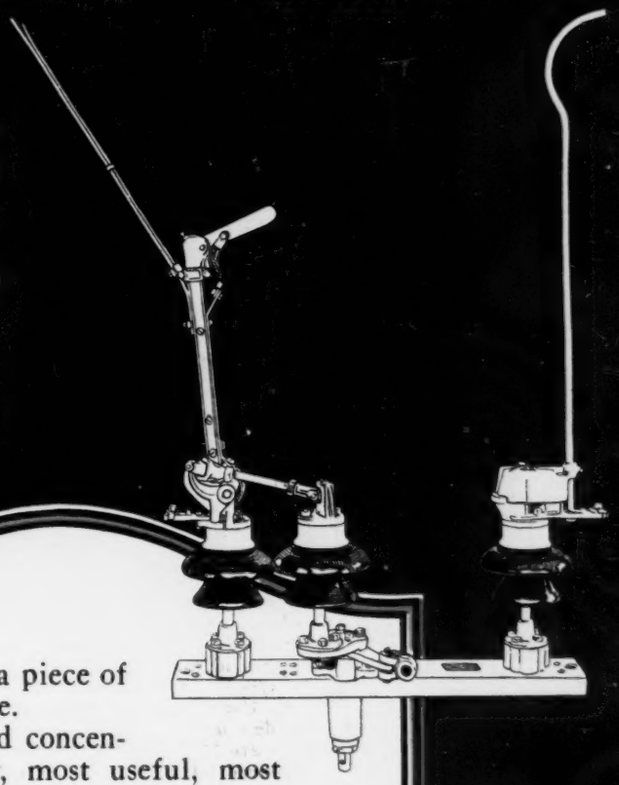
Makers of Wire Rope and Wire

John A. Roebling's Sons Company

Trenton, New Jersey

ENGINEERING MANUFACTURING ASSEMBLY

Good Work Is Not Done With One Eye On The Price - - -



Hi-Voltage has never turned out a piece of equipment with one eye on the price.

In designing, we forget price, and concentrate everything to make the best, most useful, most durable job.

In manufacture, we do the same.

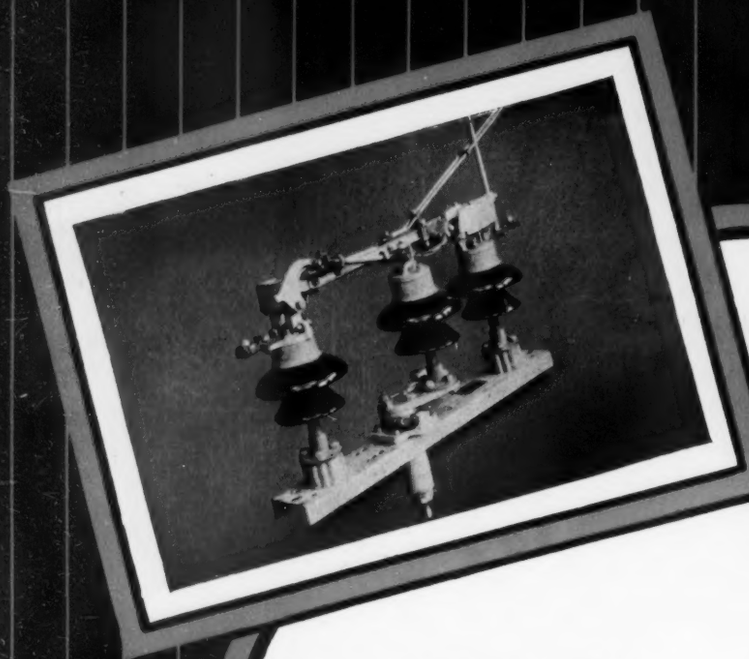
The entire line of Hi-Voltage Outdoor Equipment—Air Break Switches, Gang and Hook Disconnects, Fuses, Choke Coils, Bus Supports, Connectors, shows a skill of design—a finish in manufacture that means quality only.

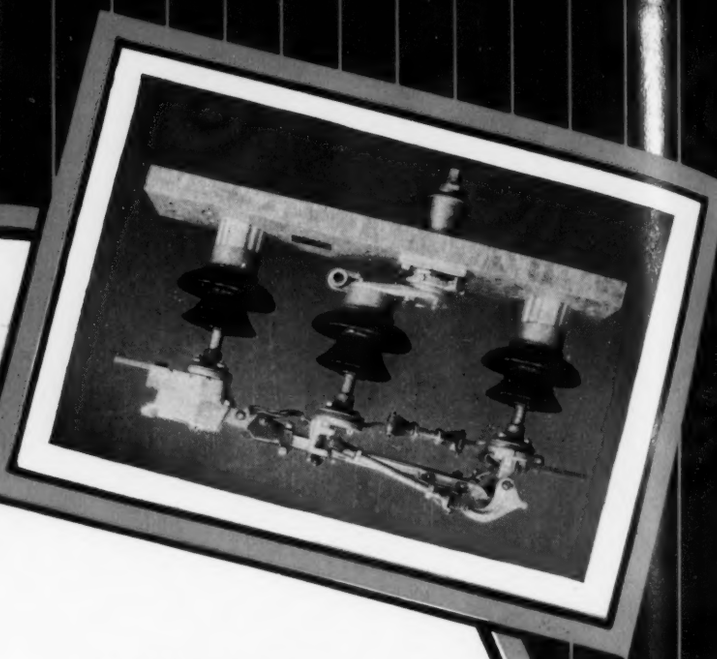
Patronage we have enjoyed for these years convinces us that engineers appreciate equipment made to such standards.

Experience has shown that superior wear, reliability, convenience we have built into this equipment pays our patrons in the long run.

Hi-Voltage Equipment Co.
Cleveland, Ohio, U. S. A.

HI VOLTAGE SWITCHES





Hi-Voltage Air Break Switches

Vertical type—arc is formed and broken at top of arching horns. Main contacts can never burn. Never fails to clear heaviest loads.

Monel ball and bronze race bearings make oiling unnecessary, and keep switch operable in spite of weathering.

Contacts will always carry the load—no matter how dirty or corroded. Sleet protection adequate.

A well designed, well finished, sturdy switch which is giving satisfaction to the highest degree in many installations.

Hi-Voltage Gang Disconnects

Our line of gang disconnects is of wide variety, and will meet any conceivable operating condition.

Two types—side opening and vertical opening. Contacts are of the same fundamental design as our air break switch. Bearings are Monel ball and bronze race—never need lubrication. Even a 6 pole 800 ampere switch always operates smoothly.

May be electrically interlocked with oil circuit breakers, so they cannot be opened when the circuit breaker is closed.

Hi-Voltage Fuses

No fusing problem has ever been put up to us that could not be solved with the Hi-Voltage Fuse. The fastest operating fuse obtainable, it can absolutely be depended upon to clear in one cycle, and at the zero point of the wave.

These fuses have been tested under severest conditions, under heaviest loads, and never fail to clear. As a result, many of the largest central stations are using Hi-Voltage Fuses as standard.

Fuse links, which cost only a few cents, are quickly replaceable in the field.

Hi-Voltage Hook Disconnects

More than a built-up knife switch, the Hi-Voltage Hook Disconnect presents a great advance in design and workmanship.

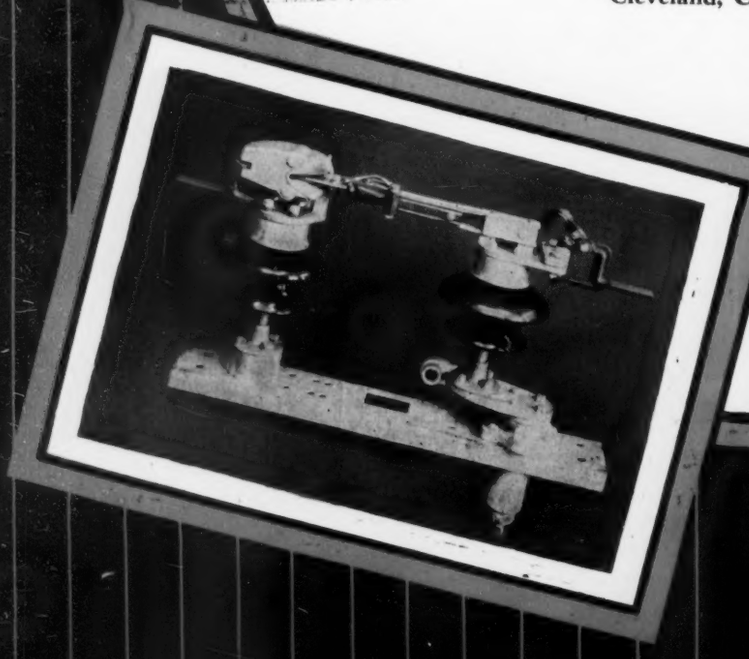
The jaw consists of a center piece, which forms the contact between the double blade, also contact fingers engage the outer surfaces of the blades.

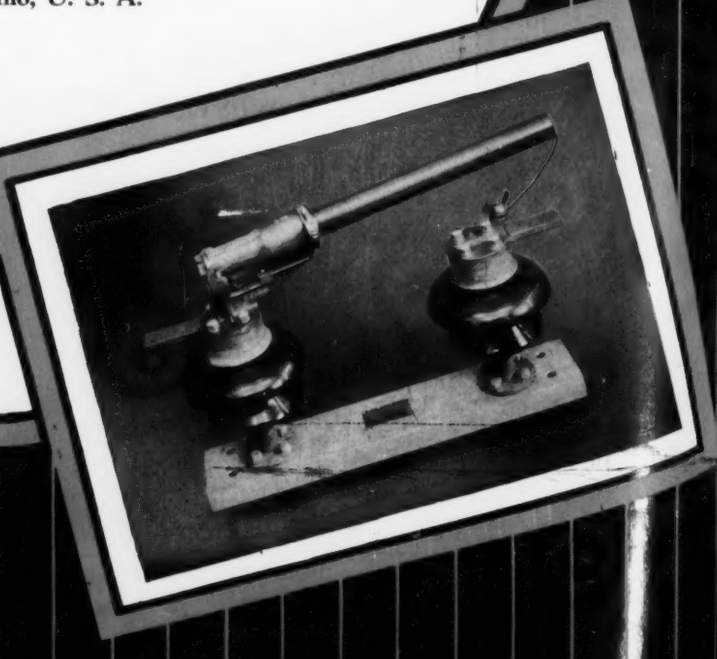
Hinge is under positive pressure through a 76 lb. compression spring. The lock is a substantial sliding bolt, similar to a heavy door latch.

Accuracy of machining, quality of workmanship are of high order.

Enduring in conductivity — easy of operation.

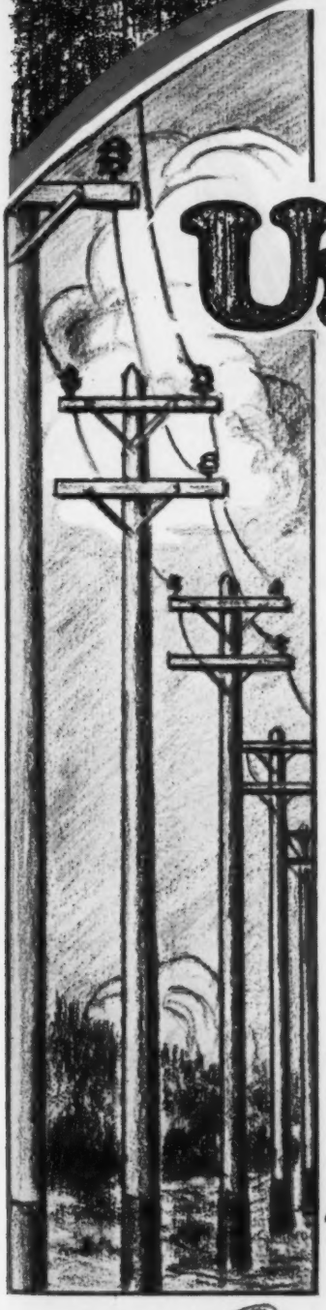
Hi-Voltage Equipment Co.
Cleveland, Ohio, U. S. A.





BUILT BY NATURE

Uniformity



Western Red Cedar poles are characterized by their great regularity in shape and size. If they were built to order, over the same pattern, their consistent features could not very well be improved upon. Each pole has the same regular and uniform taper as its neighbor in the line, and is singularly well adapted and fitted for pole service.

Just as they possess the same trim and sightly appearance, so they have the inherent and enduring strength that makes them ideal for pole purposes.

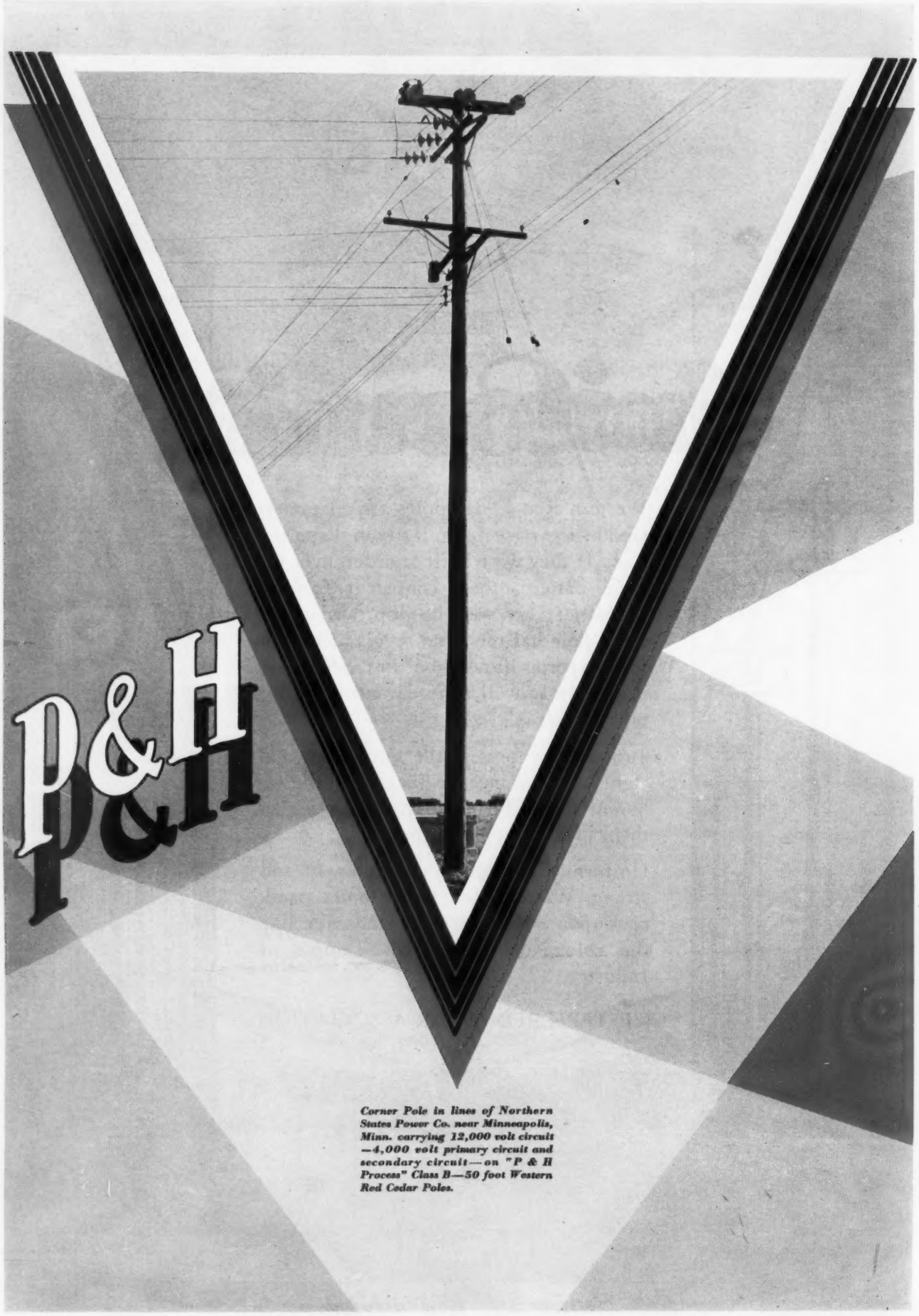
Uniformly straight, clean, shapely and strong, Western Red Cedar poles stand, row upon row, across the landscape like the colonnade of a great Temple of Industry.

WESTERN RED CEDAR ASSOCIATION

Executive Offices, Spokane, Wash. Research Division, Minneapolis, Minn.

western red cedar poles

the choice of the utilities



Corner Pole in lines of Northern States Power Co. near Minneapolis, Minn. carrying 12,000 volt circuit —4,000 volt primary circuit and secondary circuit—on "P & H Process" Class B—50 foot Western Red Cedar Poles.

What is the Life of a "P&H Process" Pole?

FREQUENT inspections of "P & H Process" Poles set in lines located in different sections of the country, plus data given us by other users, discloses no evidence of decay and a sufficient amount of free oil throughout the groundline area of the poles to assure a protection of over 30 years in addition to its untreated natural life of 13½ years (as given in Report of Committee on Preservation Treatment of Poles and Cross Arms-Proceedings of N. E. L. A.)

Thirty-five to forty years is, therefore, a conservative estimate for the life of a "P & H PROCESS" Pole. This long life is made possible by a thorough understanding of the principles of wood preservation, the ability to correctly apply these principles and a predetermined standard for everything done in the manufacture and Butt-Treating of "P&H Process" Cedar Poles.

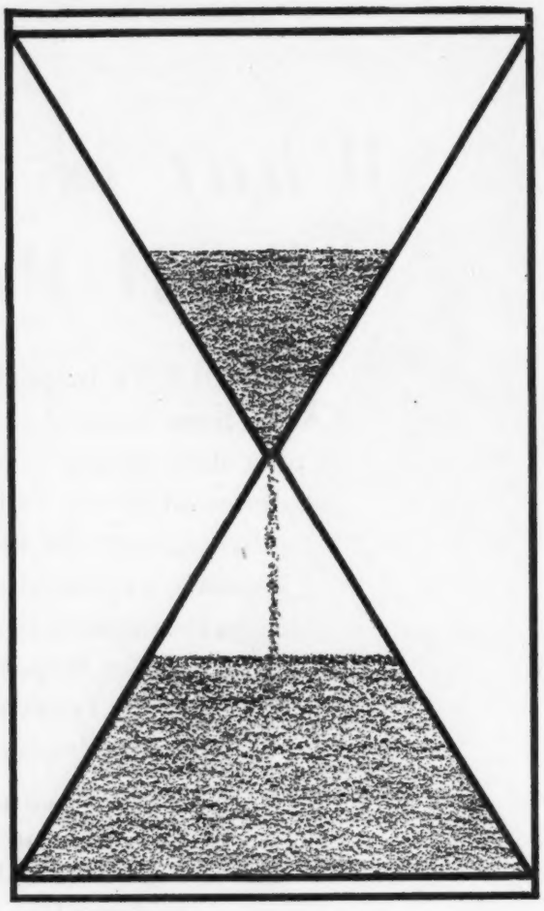
All Cedar Pole requirements . . . Northern White Cedar or Western Red Cedar.

"Still in the Lead"

PAGE AND HILL CO.

MINNEAPOLIS, MINN.

New York, N. Y., 50 Church St.
Chicago, Ill., 19 So. La Salle St.
Boston, Mass., 733 Public Service Bldg.
Kansas City, Mo., 517 Pioneer Trust Bldg.
Dayton, Ohio, 854 Reibold Bldg.
Omaha, Neb., 711 Electric Bldg.



The Fourth Dimension

It is generally accepted that length, breadth and thickness are the practical dimensions the engineer uses in specifying substation equipment.

There is however a FOURTH dimension which is all-important, and is usually dictated by his sixth sense:

EXPER

220 Volts to 275,000 Volts

Some of the better known Elpeco installations

275,000 VOLTS

Public Service Electric & Gas Co.
3-pole, motor driven, disconnecting switches at Roseland, N. J., Substation.

220,000 VOLTS

Southern California Edison Co.
3-pole disconnecting switches at Eagle Rock Substation.

Philadelphia Electric Company
3-pole disconnecting switches at Plymouth Meeting Substation.

Phoenix Utility Company
3-pole disconnecting switches at Siegfried, Pa.

Phoenix Utility Company
3-pole disconnecting switches at Bushkill, Pa.

187,000 VOLTS

Duke Price Power Company
3-pole disconnecting switches at Isle Magline, Canada.

150,000 VOLTS

Sherman Power Construction Co.
3-pole horn gap switches, Monroe Bridge, Mass.

132,000 VOLTS

Penna. Water & Power Co., Holtwood, Pa.
Commonwealth Edison Co., Chicago, Ill.
Metropolitan Power Co., Middletown, Penna.
Phoenix Utility Co., American Falls, Idaho.

120,000 VOLTS

Tennessee Electric Power Co., Chattanooga, Tenn.
Mercer Co. Light Heat & Power, Co., Sharon, Pa.

110,000 VOLTS

Washington Water Power Co., Spokane, Wash.
New England Power Constr. Co., Reedsboro, Vt.
Philadelphia Electric Co., Philadelphia, Pa.
Western Canada Power Co., Elk Lake, Ont.
Turner Falls Power Co., Greenfield, Mass.
Penn Central Lt. & Power Co., Shade Gap, Pa.

88,000 VOLTS

Southern Ohio Power Co., Athens, O.
Appalachian Electric Power Co., Saltville, Va.
Halifax Power Co., Chase City, Va.

66,000 VOLTS

Commonwealth Edison Co., Chicago, Ill.
Appalachian Electric Power Co., Cabin Creek, W. Va.
Atlantic City Electric Co., Egg Harbor, N. J.

44,000 VOLTS

Metropolitan Edison Co., Hanover, Pa.
Binghamton Lt. Ht. & Pr. Co., Johnson City, N. Y.
Penna. Edison Co., Easton, Pa.

35,000 VOLTS

Monongahela-West Penn. Public Service Co., Fairmount, W. Va.
Rochester Gas & Elec. Co., Rochester, N. Y.
Southern Ohio Power Co., Point Pleasant, W. Va.

25,000 VOLTS

Long Island R. R., East New York, L. I.
Edison Electric Co., Sinking Springs, Pa.
Atlantic City Electric Co., Atlantic City, N. J.
(All 3-pole horn gap switches)

15,000 VOLTS

Syracuse Lighting Co., Syracuse, N. Y.
Consolidated Gas Elec. Lt. & Pr. Co., Baltimore, Md.
Knoxville Power & Lt. Co., Knoxville, Tenn.

8,000 VOLTS

Morris & Somerset Elec. Co., Morristown, N. J.
Island Creek Coal Co., Huntington, W. Va.

6,600 VOLTS

Norfolk & Western Rwy. Co., Norfolk, Va.
Ky. & W. Va. Power Co., Pikesville, Ky.
(All 3-pole horn gap switches)

220 VOLTS

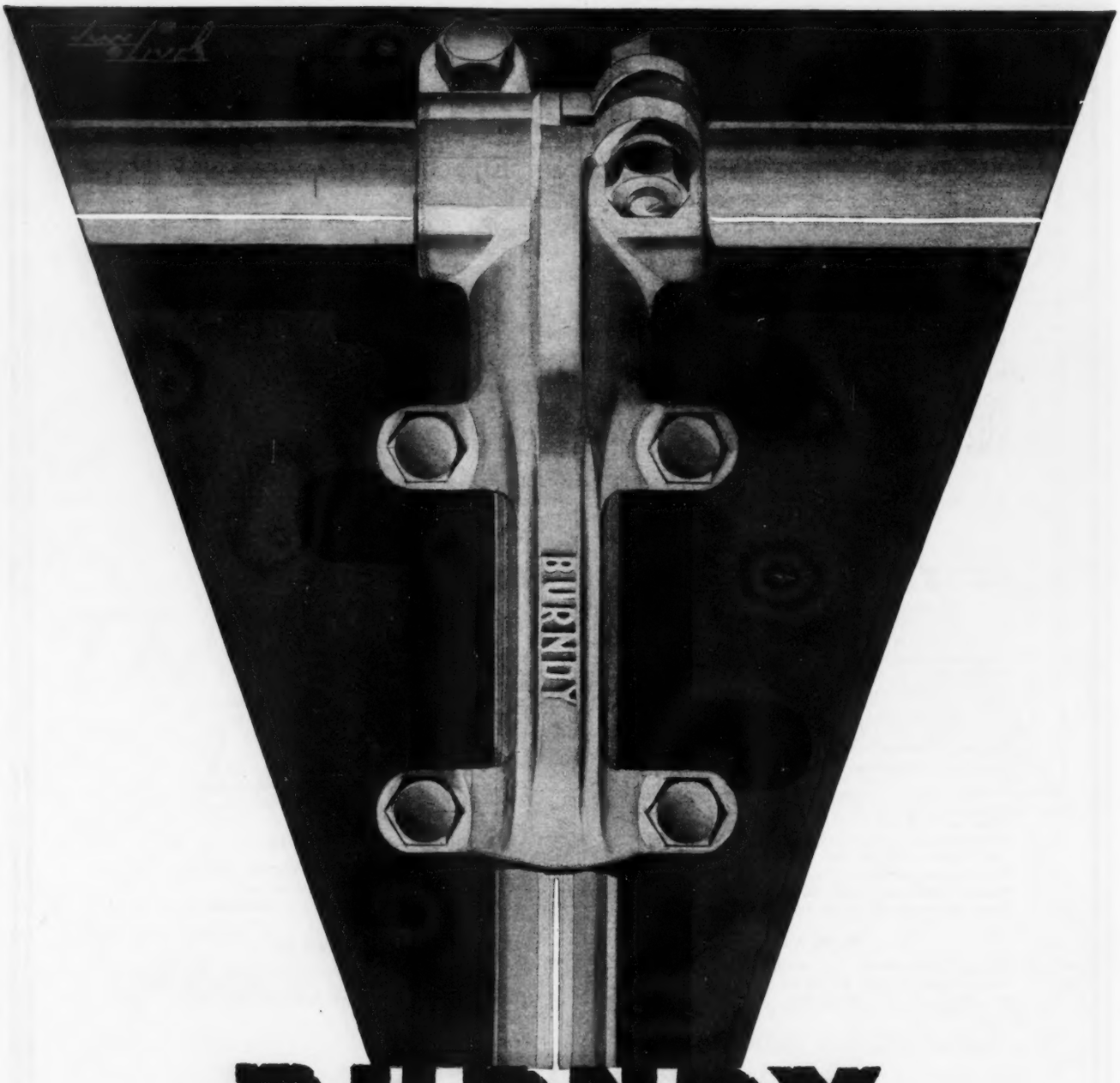
Indoor and outdoor disconnecting switches, bus supports, choke coils, fuse mountings, relay test switches, fittings, for industrial plants, mines, railroads, etc., etc.

ELPEC

ELECTRIC POWER EQUIPMENT CORPORATION

412-420 NORTH EIGHTEENTH ST. PHILADELPHIA, PA.

I E N C E



BURNDY CONNECTORS

for Bus Economy

REPRESENTATIVES:

Boston ..... J. J. Costello	Cleveland ..... A. D. Fishel Co.	Dallas ..... Elgin B. Robertson
New York ..... J. Leo Scanlon Co.	Pittsburgh ..... Henry N. Muller Co.	Denver ..... Joy & Cox, Inc.
Buffalo ..... J. Leo Scanlon Co.	Chicago ..... Frank P. Withers	San Francisco ..... H. M. Thomas Co.
Philadelph'a ..... The Bradley Co.	St. Louis ..... J. P. Lane	Los Angeles ..... L. W. Thompson
Atlanta ..... H. Douglas Stier		Seattle ..... Fred. W. Carlson

In Canada: Canadian Line Materials, Ltd., Scarboro Junction, Ont.

Home Office: Burndy Engineering Co., Inc., 10 E. 43d St., New York

A "Good Fellow" Who Can't Be Fooled

Our inspectors hear this frequently. The woodsmen know them as smiling eagle-eyed timbermen who separate strictly the unfit from the fit.

A "Black Beauty" pole must first be a suitable piece of timber. This is the initial step in the "Black Beauty" line of production. Every succeeding step is taken with the same care.

Pole life is dependent upon this exactness.

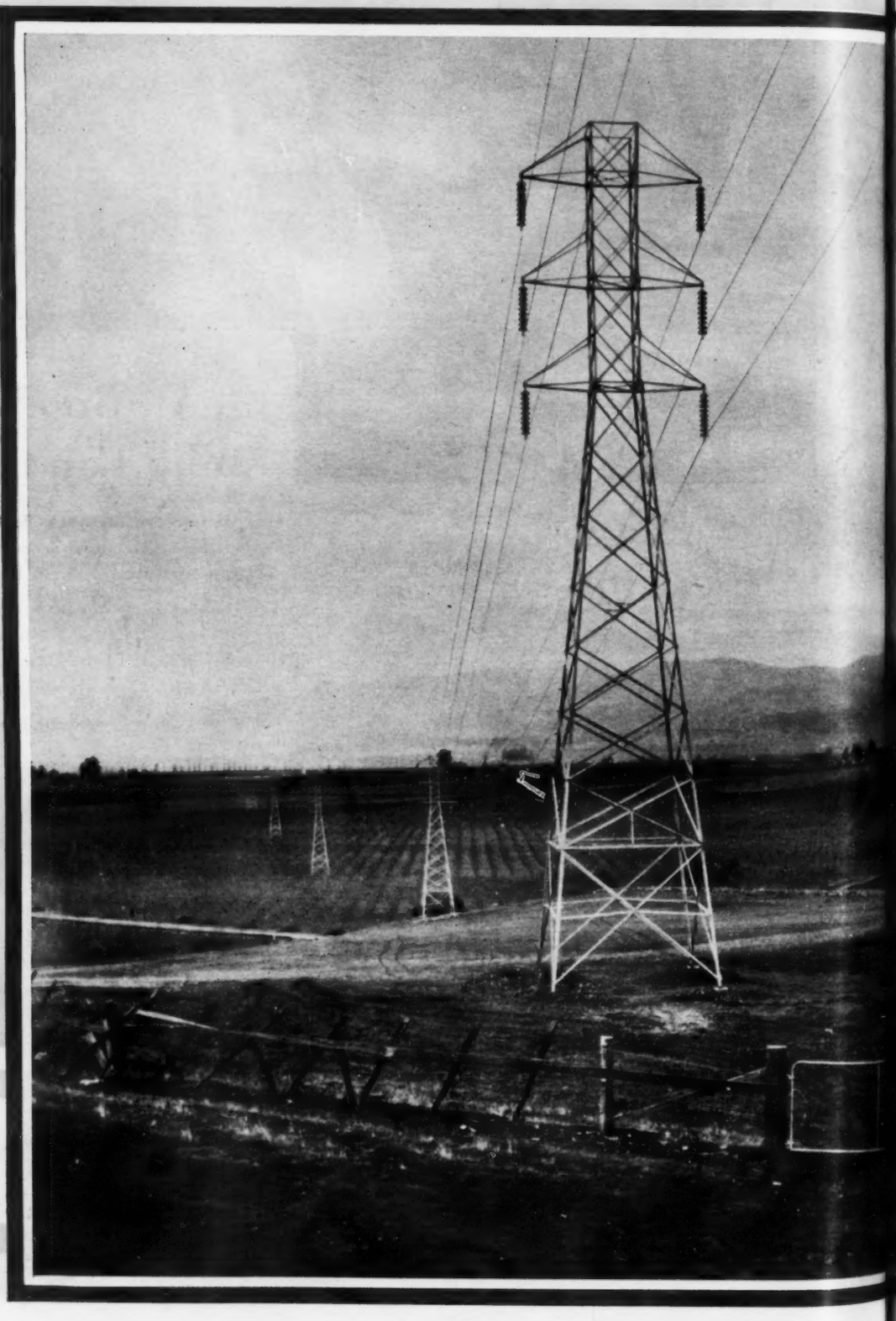
The same care that goes into the selection of timber for "Black Beauty" poles is continued through the entire manufacturing process. Each step is accompanied by an inspection as rigid as that conducted in the field. They come to you uniformly excellent and durable---ready for generations of service---backed by the guarantee of this organization and the integrity of the men of whom this company is composed.

Black Beauty Poles

TEXAS CREOSOTING COMPANY
ORANGE, TEXAS HOUSTON, TEXAS

It's What's Inside That Counts

THROUGH *the* MOUNTAINS



with J-D's

Where the heat of mid-day and the cold of the mountains at night, combine to give insulators maximum changes from hot to cold every 24 hours, J-D's heavy thick porcelain discs are in great favor.

This installation happens to be on the lines of the Pacific Gas & Electric Co. Others, however, are in the tropics, in South America, at the Panama Canal, in the South Pacific and elsewhere.

If you have a similar problem, involving sudden changes of temperature throughout a wide range—get in touch with J-D. If your big problem is lightning, do likewise.

JEFFERY-DEWITT
INSULATOR COMPANY
KENOVA WEST VA.

JEFFERY-DEWITT

More MacGillis Service

Continuous growth in industry results from giving satisfaction through conscientious service.

The MacGillis & Gibbs Company again announces increased facilities by the enlargement of their Cedar yards at Minnesota Transfer, including a new and modern plant for the open-tank treatment of Cedar Poles, guaranteed penetration process.

This plant has a daily capacity of six carloads and is complete with ample creosote oil storage, a puncture machine for the incising of poles, greatly enlarged storage facilities, the last word in modern mechanical equipment for the economical and efficient transportation of poles about the yard, additional track facilities, etc.

These increased facilities will enable the MacGillis & Gibbs Company to handle their constantly increasing volume of business with even greater efficiency.

The MacGillis & Gibbs Company

New York
220 Broadway

120 E. Wisconsin Ave.
Milwaukee, Wisconsin

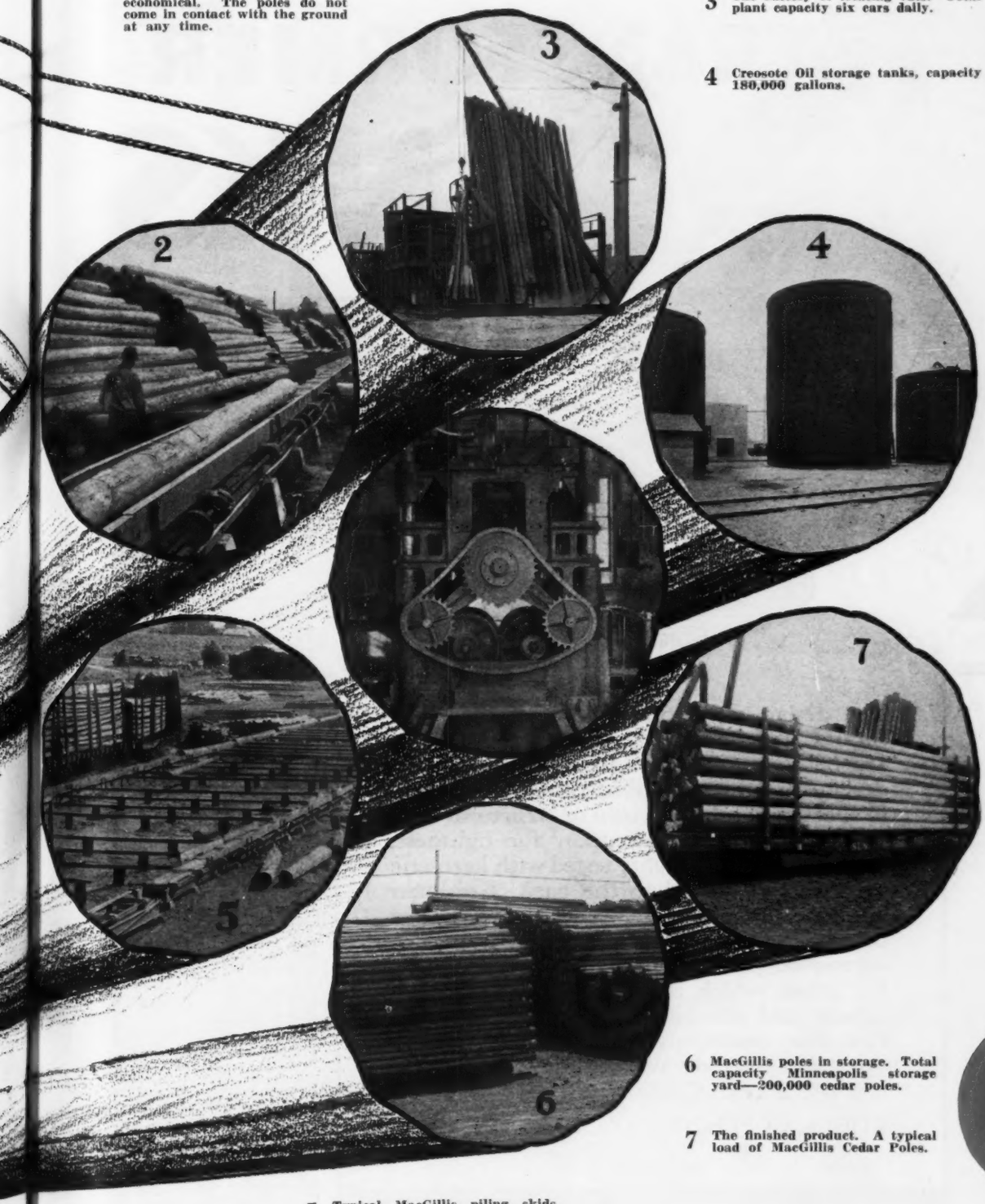
Chicago
80 E. Jackson Blvd.

1 Puncture Machine, MacGillis design, to incise poles for penetration treatment.

2 Live roll equipment to transport poles about the yard fast and economical. The poles do not come in contact with the ground at any time.

3 One battery of treating vats. Total plant capacity six cars daily.

4 Creosote Oil storage tanks, capacity 180,000 gallons.



6 MacGillis poles in storage. Total capacity Minneapolis storage yard—200,000 cedar poles.

7 The finished product. A typical load of MacGillis Cedar Poles.

5 Typical MacGillis piling skids three feet high of creosoted timber, free from vegetation.

MacGillis Poles

TRANSFORMER TANKS

Tank for large distribution transformer

The design and construction of the tanks should not be overlooked when transformers are being compared. ¶ Kuhlman tanks are designed so that the oil is contained entirely in sheet steel—the cast iron or structural steel base is not depended upon for tightness. Each tank is thoroughly tested with kerosene before it is secured to the base. Kuhlman Transformer tanks are made from copper bearing steel that offers greater resistance to corrosion. Additional resistance is added by the paint, which is a combination of metal primer and enamel. ¶ There are many factors that contribute to the reliability and operating economy of Kuhlman Transformers—this is one of them.

KUHLMAN ELECTRIC CO., BAY CITY, MICH.

KUHLMAN TRANSFORMERS

Akron, Ohio
Electric Motor & Repair Co.
High and Barges Sts.

Atlanta, Georgia
E. K. Higginbottom
1431 Healy Bldg.

Baltimore, Md.
Industrial Power Equip. Co.
421 W. Camden St.

Boston, Mass.
Geo. H. Wahn Co.
69-71 High Street

Buffalo, N. Y.
John E. Hoffman
280 Carolina St.

Chicago, Ill.
John R. Smith
844 Rush St.

Cincinnati, Ohio
S. L. Currier
833 Union Trust Bldg.

Cleveland, Ohio
Public Service Supply Co.
627 Union Trust Bldg.

Dallas, Texas
F. T. Morrissey & Co.
1408 Allen Bldg.

Denver, Colo.
Electric Sales Co.
1535 Broadway

Detroit, Michigan
Richard P. Johnson
10-230 General Motors Bldg.

Indianapolis, Indiana
Scott Jacqua Co., Inc.
202 Indiana Terminal Whse.

Lincoln, Neb.
Enterprise Electric Co.
1425-35 M. St.

Los Angeles, Cal.
Thomas Machinery Co.
912 E. 3rd St.

Milwaukee, Wis.
Wm. H. Fernholz
1031 Clybourn St.

Minneapolis, Minn.
Joseph L. Barnard
2101 Blaisdell Ave.

Montreal, Quebec
W. O. Taylor & Co.
415 Canada Cement Bldg.

New Orleans, La.
Lyman C. Reed
1230 Hibernia Bank Bldg.

New York, N. Y.
D. F. Potter, Jr.
Graybar Bldg.

New York (Export)
Parr Electric Export Corp.
77 Warren St.

Omaha, Neb.
J. H. Nicholson
6315 N. 33rd St.

Philadelphia, Pa.
J. Edward Bolich
1015 Chestnut St.

Pittsburgh, Pa.
Continental Sales & Eng. Co.
839 Oliver Bldg.

Rochester, N. Y.
Geo. W. Foote
601 Temple Building

San Francisco, Cal.
C. F. Henderson
Call Building

Seattle, Wash.
Equipment Sales Co.
514 Lloyd Bldg.

Tampa, Fla.
Tampa Hardware Co.
Polk & Morgan Sts.

Toledo, Ohio
Howard J. Wittman
319 Spitzer Bldg.

York, Pa.
Harry W. Motter
25 N. Duke St.

NAUGLE FRAMING SERVICE

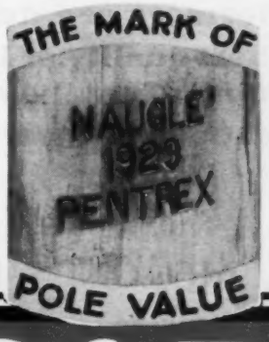
A better job for less money

A comparison of the cost of framing poles when done by the linemen on the job, with Naugle charges for the same work, will prove conclusively that the latter are decidedly cheaper.

The figures from the cost sheets of several representative utilities indicate that a saving of approximately 75% can be effected by having this work done at the Naugle yards.

By means of more efficient equipment and more convenient working conditions, Naugle can carry on this work to better advantage than your linemen in the field and the economy effected is being passed on to you, as an added feature of Naugle Pole Service.

WESTERN AND NORTHERN CEDAR
With or without butt-treatment



NAUGLE POLES

—FOR NEARLY HALF A CENTURY

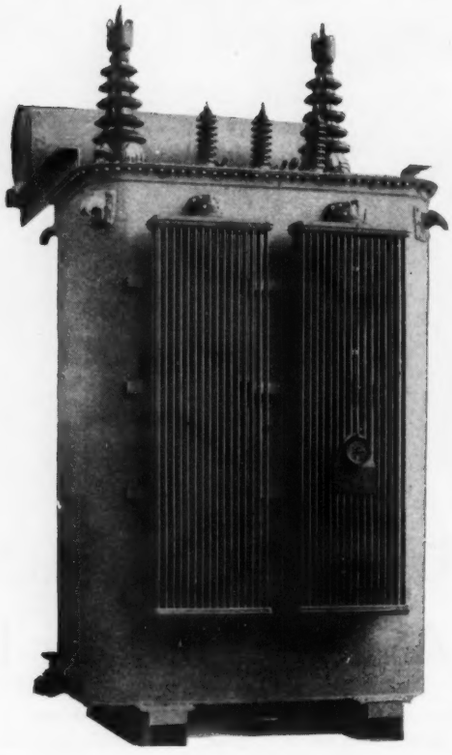
Complete facilities for framing, shaving and color staining of poles

NAUGLE POLE & TIE COMPANY *59 East Madison St., Chicago*

BRANCHES: New York, Columbus, Kansas City, Spokane, Boston, Madison, Los Angeles
MAIN YARDS AND BUTT-TREATMENT PLANTS: Minneapolis, Pinconning, Mich.; Spokane, Sand Point, Idaho; Seattle.

Canadian Northern Electric Distributors

Transformer Insulation



INSULATION is the most important fundamental in the design and construction of transformers. Moloney transformers are designed with high factors of safety, and the best quality of insulating materials is used in their construction. They have stood the test of years of continuous and satisfactory service in all parts of the country.

MOLONEY ELECTRIC COMPANY, ST. LOUIS, MO.

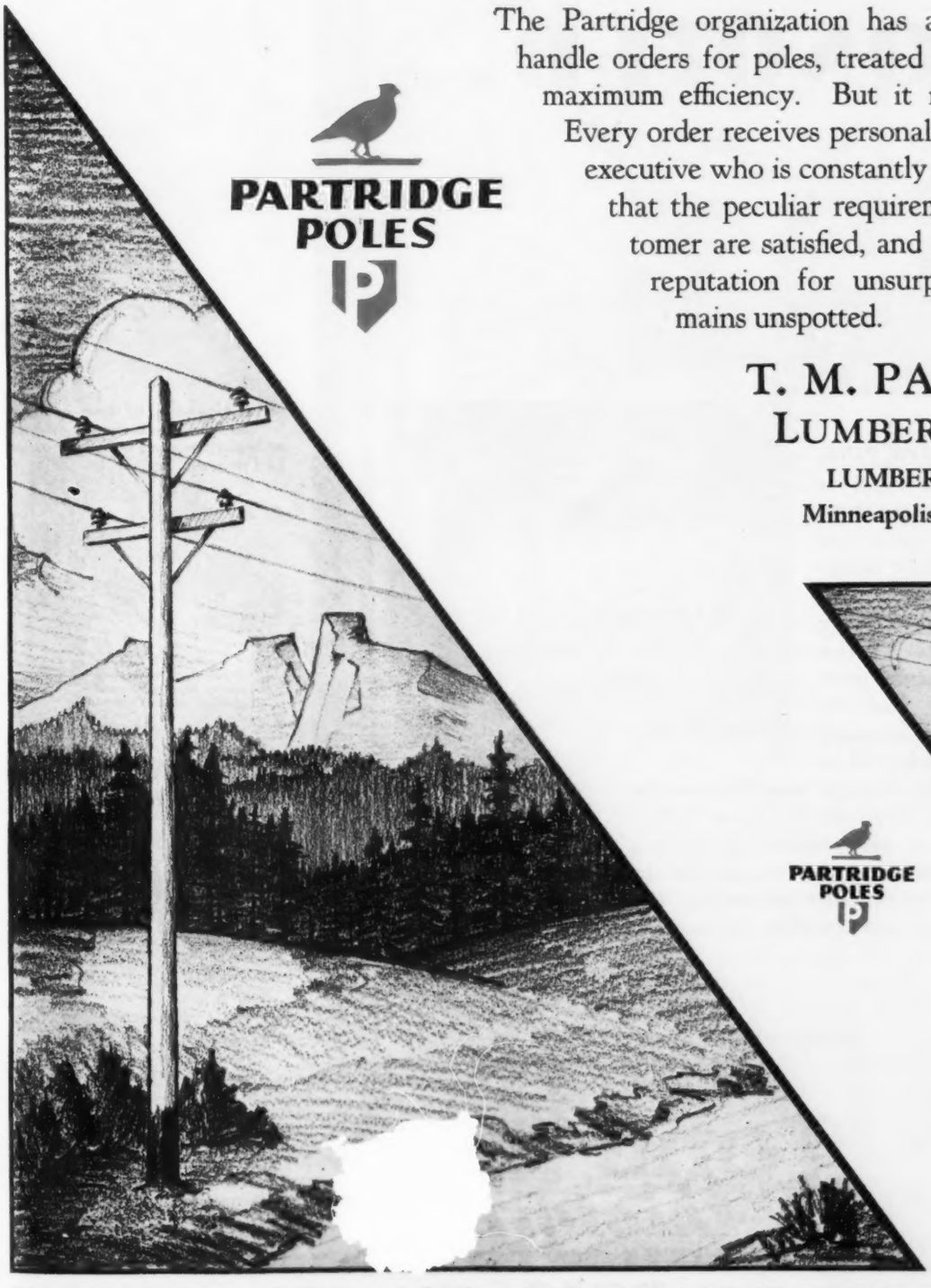
MOLONEY TRANSFORMERS

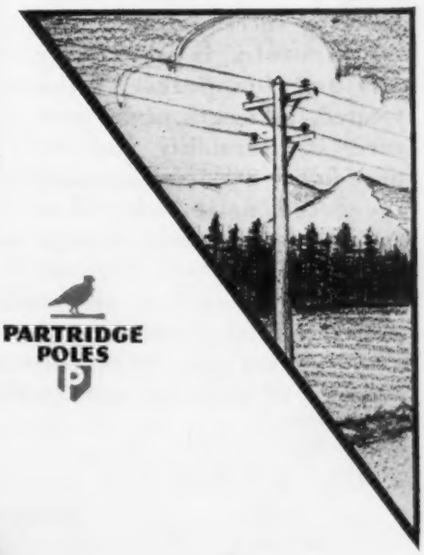
Partridge pole service is quick and dependable

Order Partridge poles and you can rest assured that you will get delivery in the shortest possible time. You can be equally certain that every pole in your shipment will be right. Every one will come up fully to specifications.

The Partridge organization has ample facilities to handle orders for poles, treated and untreated, at maximum efficiency. But it is not overgrown. Every order receives personal attention from an executive who is constantly on the alert to see that the peculiar requirements of each customer are satisfied, and that the Partridge reputation for unsurpassed service remains unspotted.

PARTRIDGE POLES





PARTRIDGE POLES

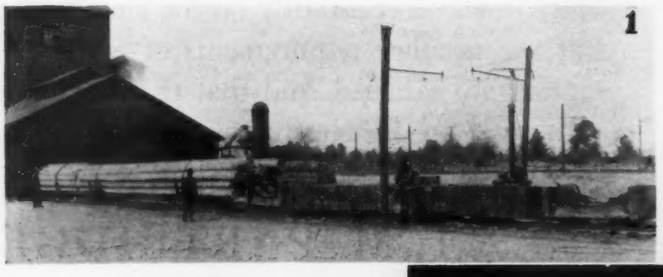
T. M. PARTRIDGE LUMBER COMPANY

LUMBER EXCHANGE

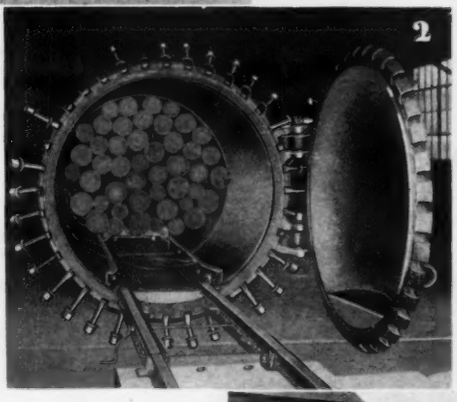
Minneapolis Minnesota

WESTERN RED AND NORTHERN WHITE CEDAR

WHEN SOUTHERN YELLOW PINE POLES ARE CREOSOTED..



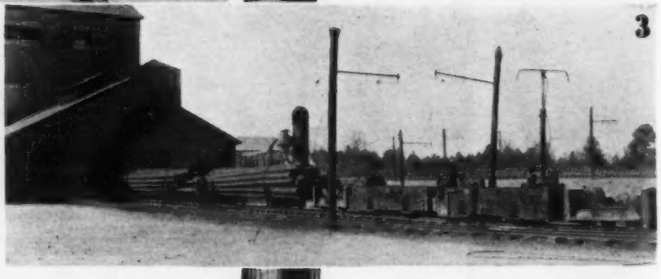
1 *A charge of poles entering a treating cylinder.*



2 *A close-up of one of the modern cylinders, adaptable for treating by any standard process.*

SOUTHERN YELLOW PINE, because its heart-wood is particularly decay resistant and the cellular structure of its sap-wood readily lends itself to successful treatment by creosote, is peculiarly adapted for poles. When treated, full length, under pressure, its durability and dependability are immeasurably increased, as it is fortified against decay, insect damage and destruction by fire. The combination of Southern Yellow Pine and Long-Bell manufacture, possessing those essential characteristics demanded by exacting service, is rapidly becoming the standard of pole line construction throughout the industry.

Let this Trade-Mark be your guide to pole purchases, your assurance of long and satisfactory service.



3 *After being treated, full length, under pressure.*

THE LONG-BELL LUMBER COMPANY

Established 1875

109 R. A. LONG BLDG. KANSAS CITY, MISSOURI

Long-Bell

CREOSOTED

YELLOW PINE POLES

Bridge builders, miners, contractors, car builders and railroad and shipyard workers need the Snell Construction Bit.

When the job demands a deep hole, the Snell Construction Bit is your one best bit.

Boring in Green wood tests the mettle of bits and men. For hard heavy duty like this the Snell Construction Bit is by test superior to all others.

Fit a Snell into the machine for that bit of tough wood work. Snell Bits are designed for heavy duty—stiffer—stronger.

No. 666. Construction Bit.

for

CONSTRUCTION

the new SNELL Construction Bit

stiffer-stronger-tougher

SEE HOW IT DELIVERS the CHIPS

Aloft with the erection crew. Swaying in the wind, a sudden lurch will bend and ruin an ordinary bit. Here the great stiffness and strength of the Snell Construction Bit makes it superior to all others.

You can sell and recommend Snell Bits on their long time merit. For rough work under severe strain and abuse. A Snell Bit will stand up on the job.

The head leads its own way through as the keen edges of unique design bite into the wood. Each bit made of Special analysis steel and tested in wood under strain before shipping.

Stiffer—stronger—tougher. Booklet and dealer information on request.

Sales Representatives

John H. Graham & Company, Inc.
113 Chambers Street
New York City

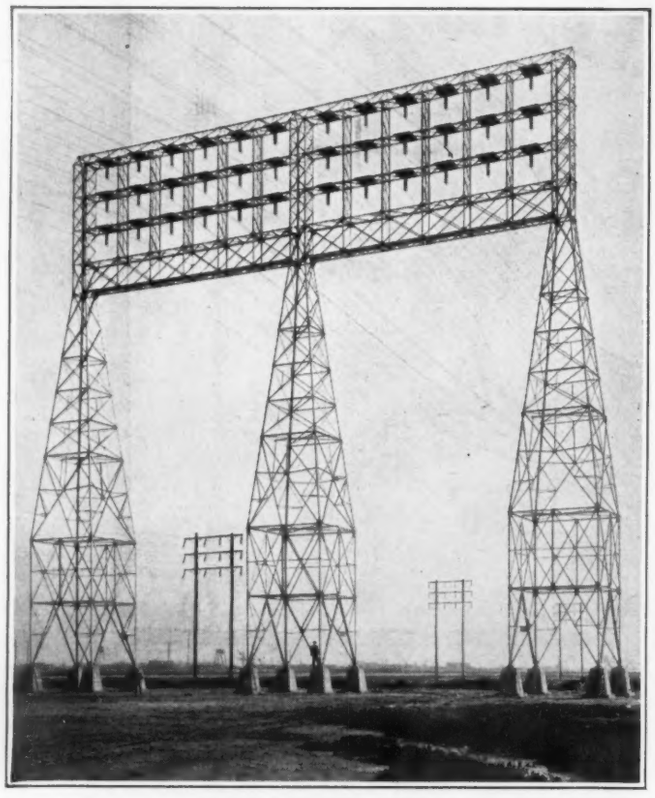
No. 660. Installation Bit.

No. 660D. Insulator Pin Bit.

Snell Manufacturing Co.

Fiskdale, Massachusetts

Multi-Circuit
Saving of

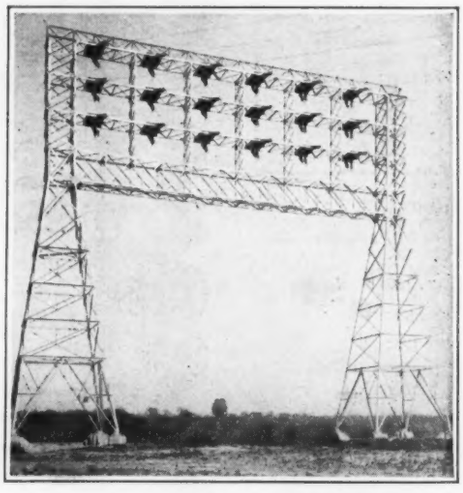


Twelve circuit 66-kv. multi-circuit tower on Long Beach to Lighthipe line. Outriggers give these structures a capacity of fourteen circuits.

REMARKABLE economies claimed for multi-circuit tower lines have been proved by the Southern California Edison Company. Savings in cost of right-of-way, construction and maintenance on these structures were so outstanding that this utility is now using them almost exclusively on transmission lines in the vicinity of Los Angeles.

Towers carrying from four to fourteen 66 kv. circuits have been erected through developed industrial, residential and agricultural areas. Economies in initial and maintenance costs have been effected in every case. (A few of the important advantages of these structures are outlined on the page opposite.)

All of these towers were manufactured by the Pacific Coast Steel Company. May our engineers and organization work with you in securing similar economies?



Six circuit 66-kv. angle tower.

Note protected runway providing access to all circuits.

PACIFIC COAST

Manufacturers of

TRANSMISSION, TOWERS

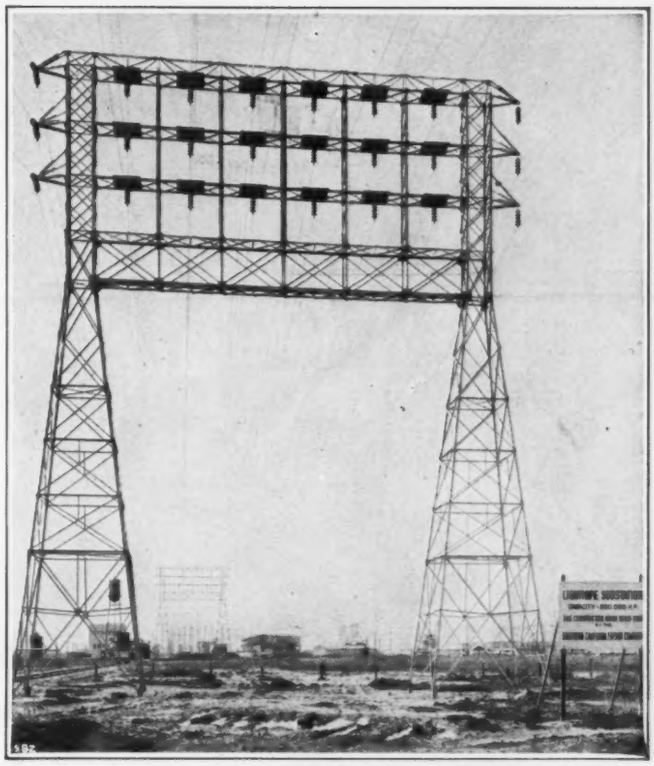
General Office: Hunter-Dulin Bldg., San Francisco

Towers Permit Over 25%

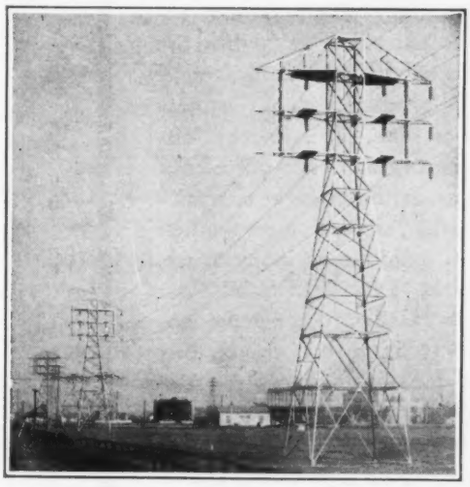
A few major advantages of multi-circuit towers.

1. Saving of at least 25% in right-of-way.
2. Saving of approximately 10% in cost of steel.
3. Saving of 30% to 60% on cost of foundations.
4. Saving of lineman's time for inspection and maintenance.
5. Ideally adapted to conditions demanding get-away with large number of circuits through high priced right-of-way areas.
6. Neater appearance offered by circuits and structures reducing objections from adjacent property owners.
7. Right-of-way used to better advantage.
8. Reduces hazard of contact with tower legs.
9. Bridge construction permits access to only cleared circuits as others are protected by locked gates.

May we send additional data?



Eight circuit 66-kv. tower with outrigger equipment. Overall width of this structure is 80 ft. permitting use of 100 ft. right-of-way.

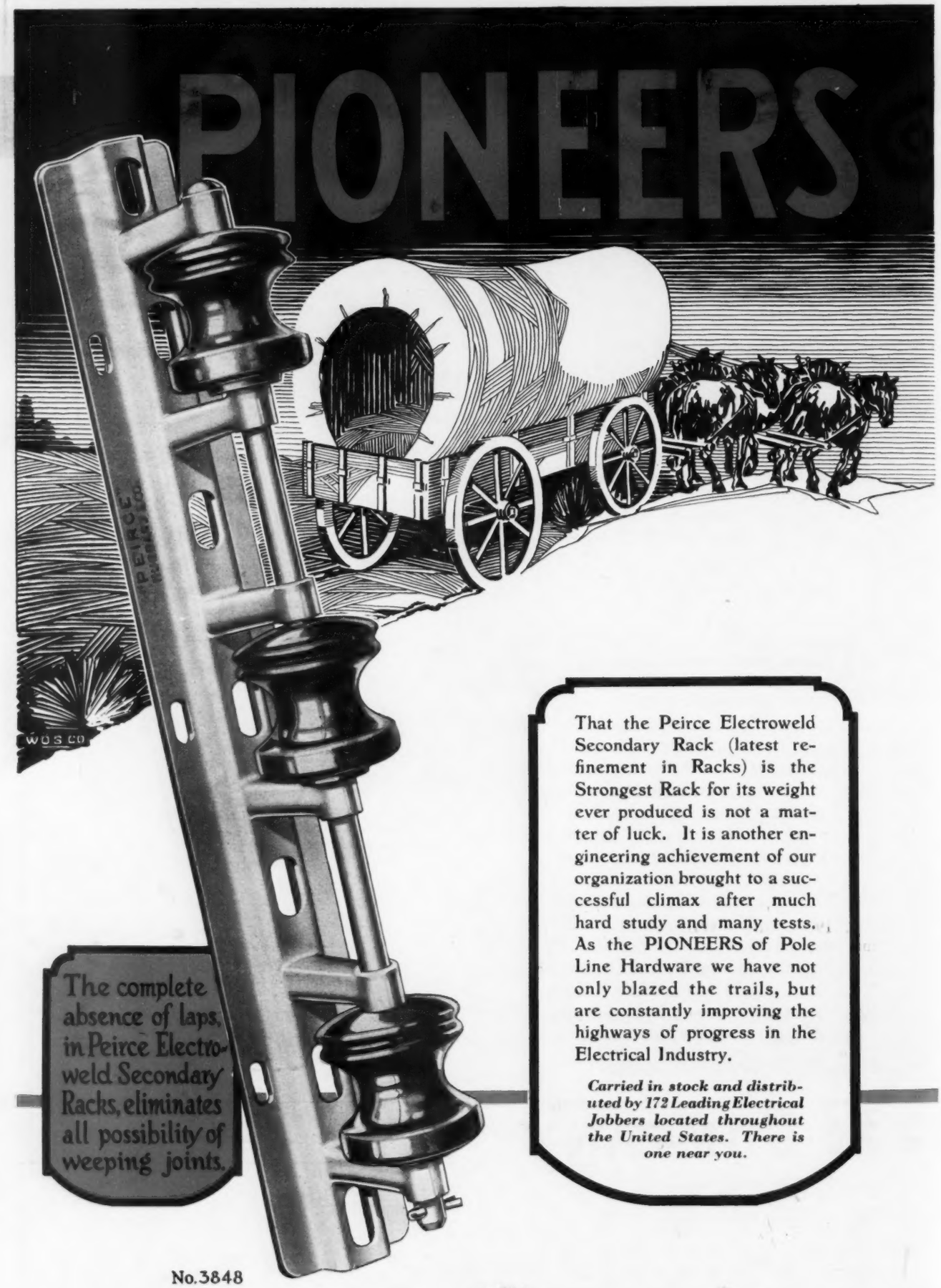


Four circuit 66-kv. towers showing economy of space and foundations.

STEEL COMPANY

OPEN HEARTH STEEL
AND STRUCTURES

Plants: San Francisco, Portland, Seattle



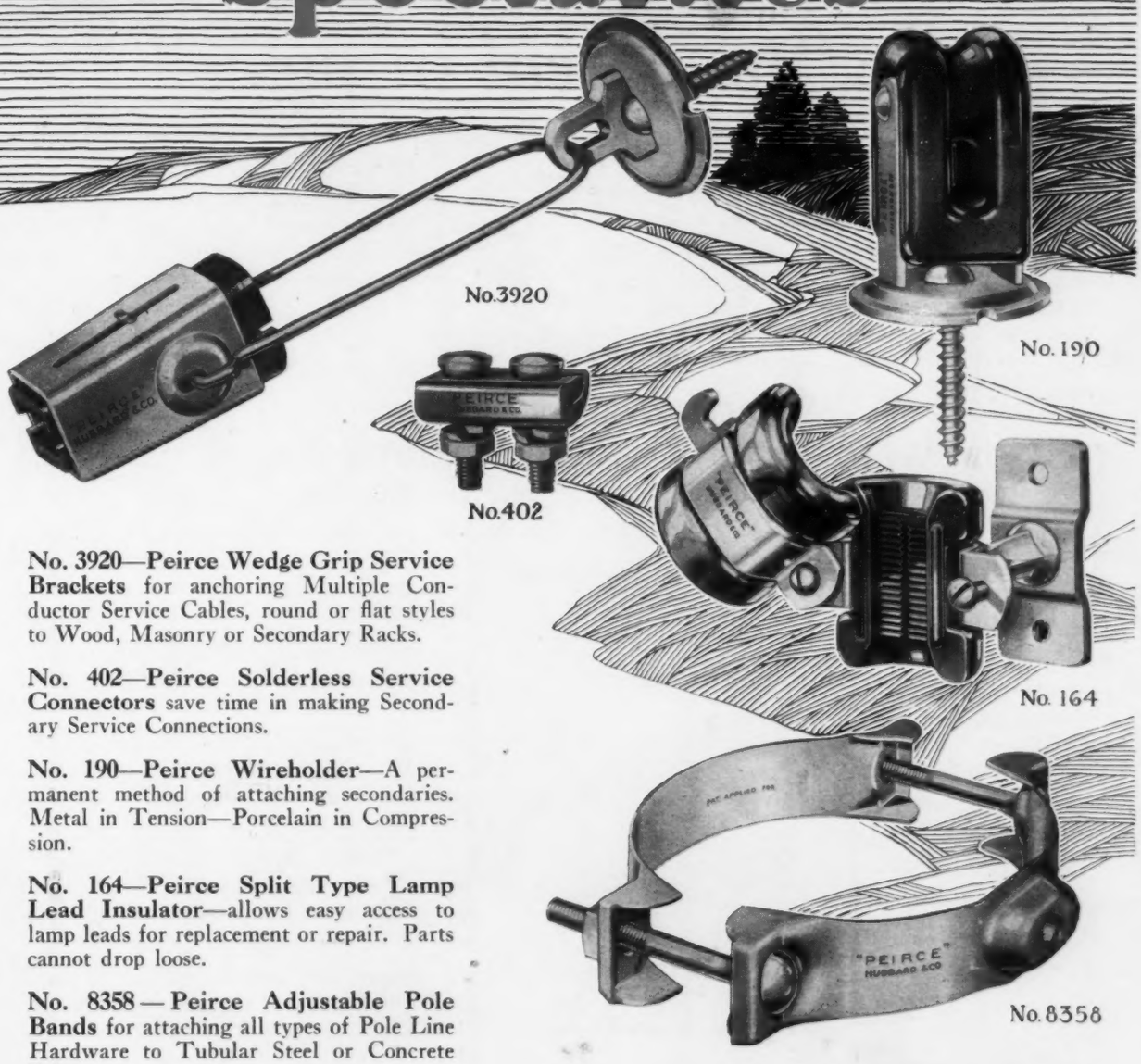
The complete absence of laps, in Peirce Electroweld Secondary Racks, eliminates all possibility of weeping joints.

No. 3848

That the Peirce Electroweld Secondary Rack (latest refinement in Racks) is the Strongest Rack for its weight ever produced is not a matter of luck. It is another engineering achievement of our organization brought to a successful climax after much hard study and many tests. As the PIONEERS of Pole Line Hardware we have not only blazed the trails, but are constantly improving the highways of progress in the Electrical Industry.

Carried in stock and distributed by 172 Leading Electrical Jobbers located throughout the United States. There is one near you.

in Pole Line Construction Specialties



No. 3920—Peirce Wedge Grip Service Brackets for anchoring Multiple Conductor Service Cables, round or flat styles to Wood, Masonry or Secondary Racks.

No. 402—Peirce Solderless Service Connectors save time in making Secondary Service Connections.

No. 190—Peirce Wireholder—A permanent method of attaching secondaries. Metal in Tension—Porcelain in Compression.

No. 164—Peirce Split Type Lamp Lead Insulator—allows easy access to lamp leads for replacement or repair. Parts cannot drop loose.

No. 8358—Peirce Adjustable Pole Bands for attaching all types of Pole Line Hardware to Tubular Steel or Concrete Poles.

Hubbard and COMPANY

PITTSBURGH • OAKLAND, CAL. • CHICAGO

BROWN

CREOSOTED YELLOW PINE PRODUCTS

300,000 Acres One of the largest

Individual Holdings in America

Why Central Station Men Like the "*new deal in poles*"

An unfailing source of supply for good uniform creosoted poles is an advantage for the Central Station executive that he has been quick to seize and appreciate.

With thousands of acres of Dense Southern Yellow Pine in the BROWN holdings, nearby to this organization's own creosoting plant, and with their own crews and equipment for handling poles from the forest to the final shipment, BROWN is in a unique position to serve creosoted pole users of the Central Station industry.

In place of many profits, the BROWN "one-organization-straight-through" method eliminates paying out an outside inspection profit, cutting profit, treating profit, etc. This means more than an operating saving—it means the ability to assure uniform quality and control deliveries.

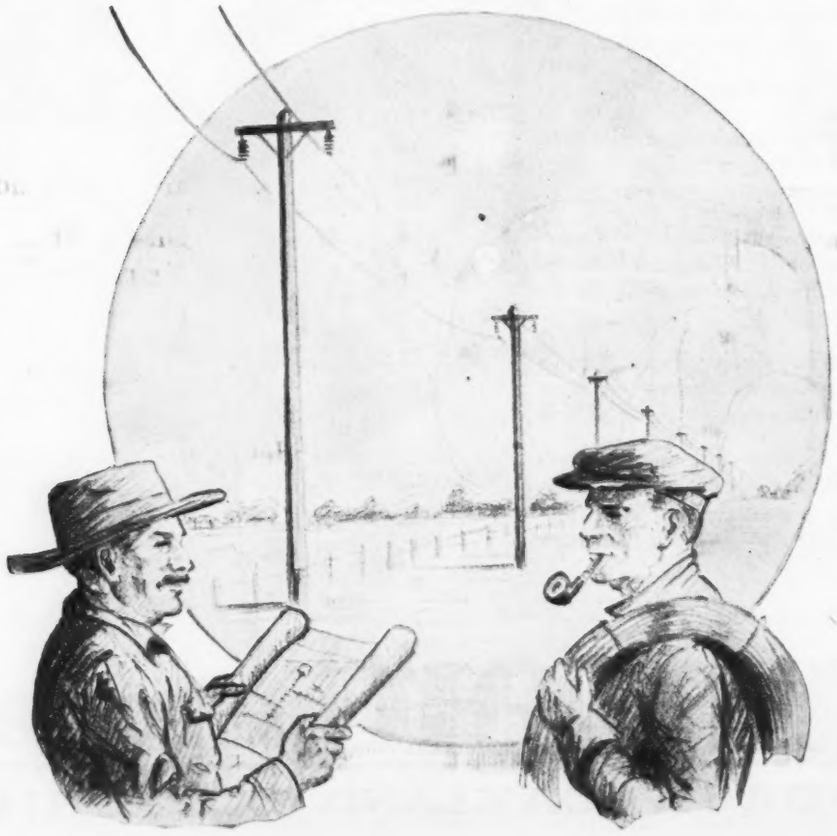
Have you the details of the "new deal in poles"?

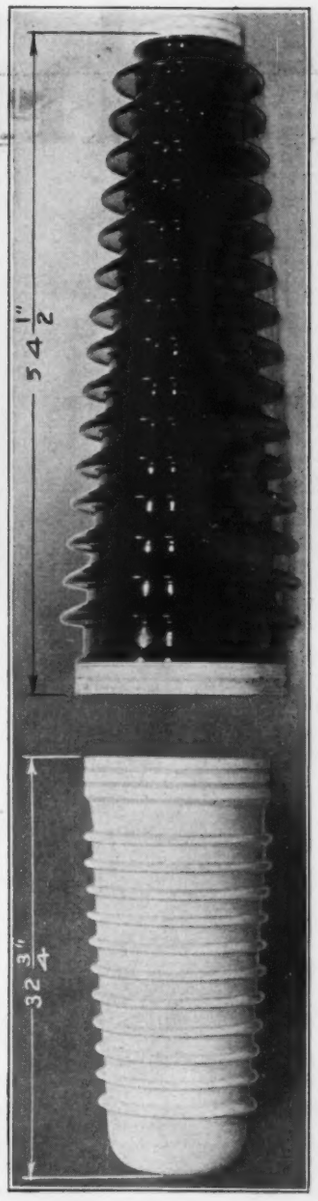
CREOSOTING DEPARTMENT

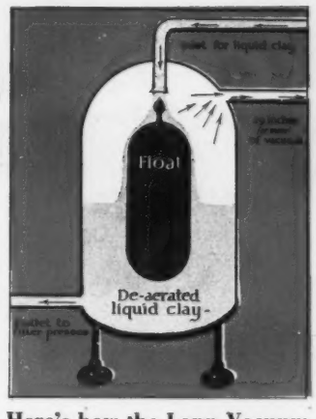
W. P. BROWN & SONS LUMBER CO., Inc.

Fourth and K Streets, Louisville, Kentucky

Telephone: Magnolia 2407

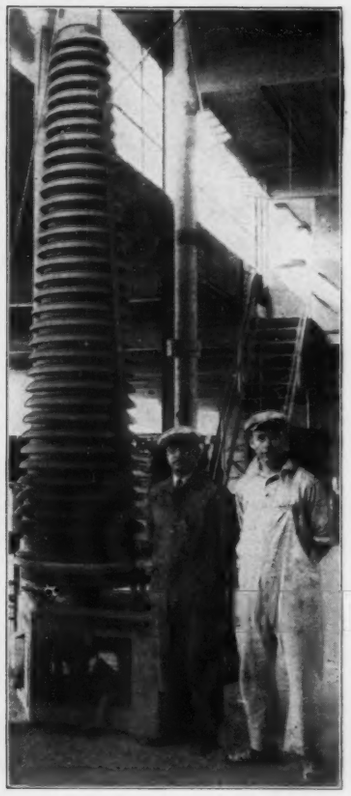






Here's how the Lapp Vacuum Process acts

LAPP INSULATORS



These Insulators Endure

THE Lapp Insulators here shown mark the very peak accomplishment of plastic, high voltage porcelain in one piece—no joints, straight as arrows, sound as bells!

Only clay freed of all occluded air made this achievement possible. The only known way of removing all the air from clay is the Lapp Vacuum Process (patented). Lapp Insulators carry up to 220,000 volts indefinitely, regardless of atmospheric conditions.

With Lapp Insulators line maintenance costs come down and stay down

LAPP INSULATOR CO. INC. LEROY·N.Y.·U.S.A.

Need anything

PINCO

more be said?

I am enclosing 2 snap shots of a pole on our Hi-Line that was struck directly by lightning during a severe storm the early part of this month. The Line sustained a direct stroke of lightning and it went to ground over 5 poles in a group, and the snap shot is of the pole that sustained the worst damages. The lightning struck the Line and the discharge was so heavy that one pole could not carry the whole of it and it apparently broke up in 5 parallel discharges. This particular pole had pieces torn out of it 6 feet long and at least 6" in diameter, the discharge travelling around the pole in a circle making about 3 turns from the top to the bottom and throwing pieces of the pole 50 feet away and so weakened the pole that it was necessary to replace it with a new one. Two other poles had slivers torn out of them but not sufficient to require their replacement.

Now the thing I know you would be interested in is that in spite of the smashing effect of the stroke as evidenced by the condition of the poles it nevertheless did no harm to the Line Insulator. We carefully examined them and found no marks or chips or anything to indicate any damage, and after replacing the Hi-Line fuses which were blown, the Line went back into service again.

This should be an excellent recommendation for the Pinco Insulator that we used on this particular job and I know you would like to know our experience with such and believe me it is a source of satisfaction to the writer to know that this insulator has stood up so splendidly under such a severe strain.

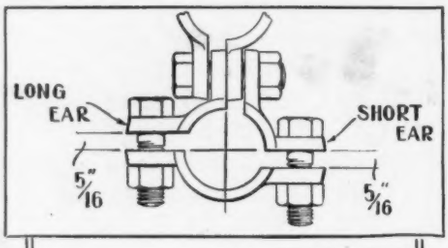
Unsolicited letter
from a Pinco user

The Porcelain Insulator Co., Lima, N. Y.

INSULATORS

SHORT EARS AND LONG EARS

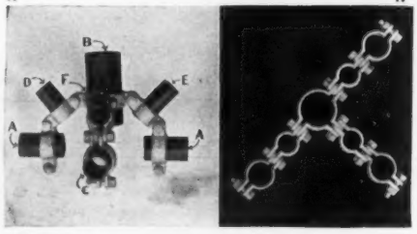
SOMETHING NEW
IN PIPE FITTINGS



SHORT EARS
EACH FITTING HAS
—A SHORT EAR
which lines up with the center line of the pipe

LONG EARS
THE FITTINGS ALSO
—HAVE A LONG EAR
which is 5/16 of an inch from the pipe center line

THE LONG EAR
—OF ONE CLAMP
ALWAYS FITS OVER
THE SHORT EAR
—OF THE CLAMP
NEXT TO IT.



The Story of The Short and Long Ears

Is told in our 36-page Bulletin No. 70

5 PARTS ONLY MAKE ANY COMBINATION 5 PARTS ONLY

These New Fittings
known as
"UNICLAMPS"
ARE THE MISSING LINK YOUR CONSTRUCTION MEN HAVE BEEN SEEKING

¶They are forged from mild steel and hot galvanized in our electrically heated galvanizing plant. Their use insures maximum strength and endurance in a minimum of space.

¶They will reduce your storeroom investment, your storage space, your engineering costs, your lost time, your installation expense.

WRITE TODAY FOR BULLETIN NO. 70

In Canada: Monarch Electric, Ltd. St. Johns, Que.

Delta INTERCHANGEABLE UNIT TYPE INSULATORS Star

In Canada: Monarch Electric, Ltd. St. Johns, Que.

DELTA STAR ELECTRIC COMPANY, 2400 BLOCK, FULTON ST, CHICAGO, ILLINOIS.

Architect, C. B. Meyers, New York, N. Y. *Switchboard Builder, Empire Switchboard Co., Brooklyn, N. Y.*

ROLLER-SMITH Instruments and Circuit Breakers

—at the Kings County Hospital, Brooklyn, N. Y.

"Over 35 years' experience is back of ROLLER-SMITH"

ROLLER-SMITH COMPANY
Electrical Measuring and Protective Apparatus

MAIN OFFICE
237 Broadway, NEW YORK

WORKS
Bethlehem, Penna.

Sales Offices in the United States

BOSTON .....88 *Broad Street*	NEW ORLEANS ..*Masonic Temple*
BUFFALO, *Ellicott Square Building*	OMAHA .....*W. O. W. Building*
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NEW YORK .....233 *Broadway*	WASHINGTON..*Evening Star Bldg.*

ABROAD

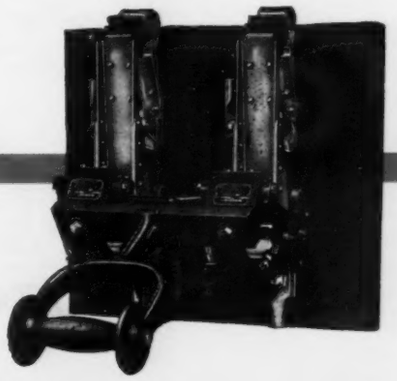
THRALL ELECTRIC COMPANY .....*Box 2049, Havana, Cuba*
DUVAL TRADING CO.....*Kembla Bldgs., Sydney, Australia*
ASHIDA ENGINEERING CO.....*Daini, Osaka, Japan*
MANILA MACHINERY & SUPPLY CO., *Box 607. Manila, Philippine Islands*

The Kings County Hospital is one of the largest and most important institutions of its kind in New York City.

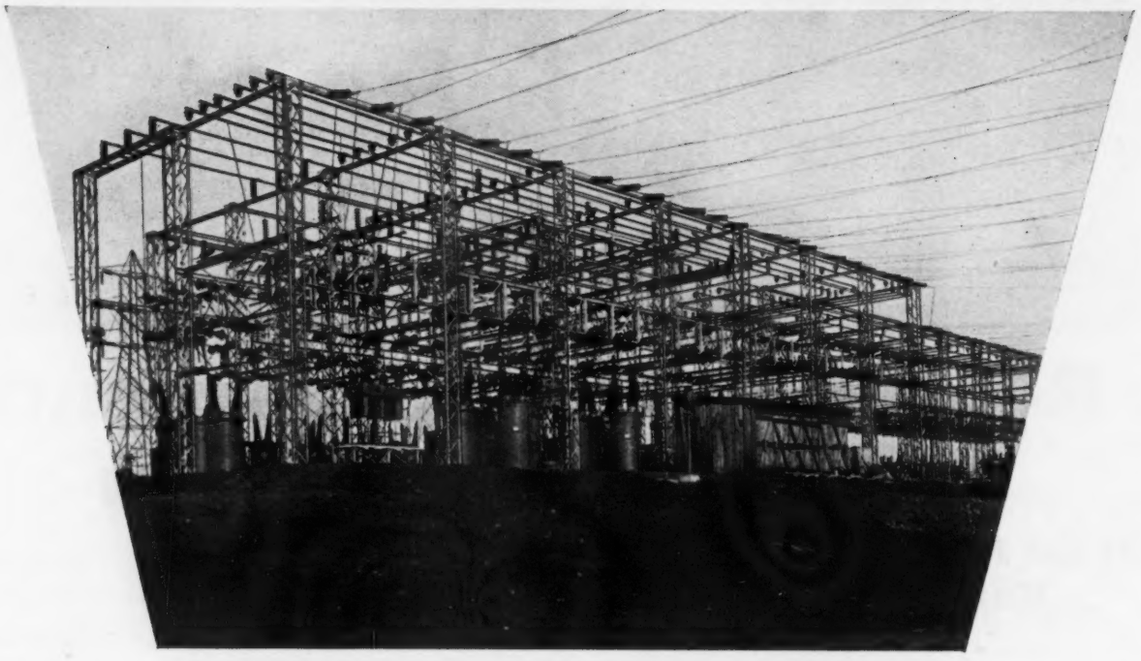
The instruments are R-S Type IDD (Illuminated Dial) voltmeters and R-S Type ND (9" diameter) ammeters.

The circuit breakers for generator protection have equalizer contacts, free-handle and time-limit overload features. The feeder breakers are of the free-handle, direct-acting time limit-type. The capacities range up to 1500 amperes. All are double pole, rigid arm.

It is significant that this is the fourth hospital in New York City which has selected ROLLER-SMITH instruments and circuit breakers. Hospitals must have dependable apparatus. "Dependable" and ROLLER-SMITH mean the same thing.



RITER CONLEY
···STEEL···
CONSTRUCTION



No Steel Construction Project Is Too Large For Riter-Conley

From the largest Hydraulic Power Plant to the smallest substation—from the highest Steel Transmission Towers carrying 220,000 volts to the construction of steel narrow base city poles—from the transmission of power from one mile to any desired distance—that is the wide scope of activity of the Riter-Conley organization—the builders of many of the most important tower projects in the world.

Some of these include towers for the high voltage ring around Chicago and Baltimore—an extensive network in North and South Carolina—lines connecting many parts in Illinois, Iowa and Missouri—also lines from Niagara to various points in New York state as well as carrying power from the coal regions of Pennsylvania to the heavy load centers of New Jersey.

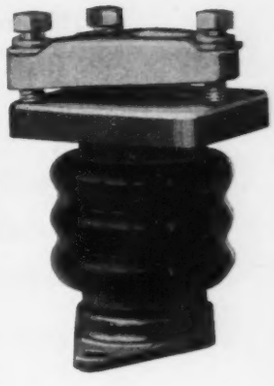
Could we offer you more convincing proof of the ability of this organization to serve your steel construction requirements superlatively well?

RITER-CONLEY COMPANY
PITTSBURGH, PA.
Branch Offices in the Principal Cities

Steel Construction Specialists for over 70 years

The SUPPORT of CAST ALUMINUM CLAMPS

WESTINGHOUSE Type H bus-bar supports are equipped with permanent mold, cast-aluminum clamps. These clamps give maximum strength, minimum weight, pleasing appearance, excellent bus contact and effectively prevent the setting up of eddy currents.



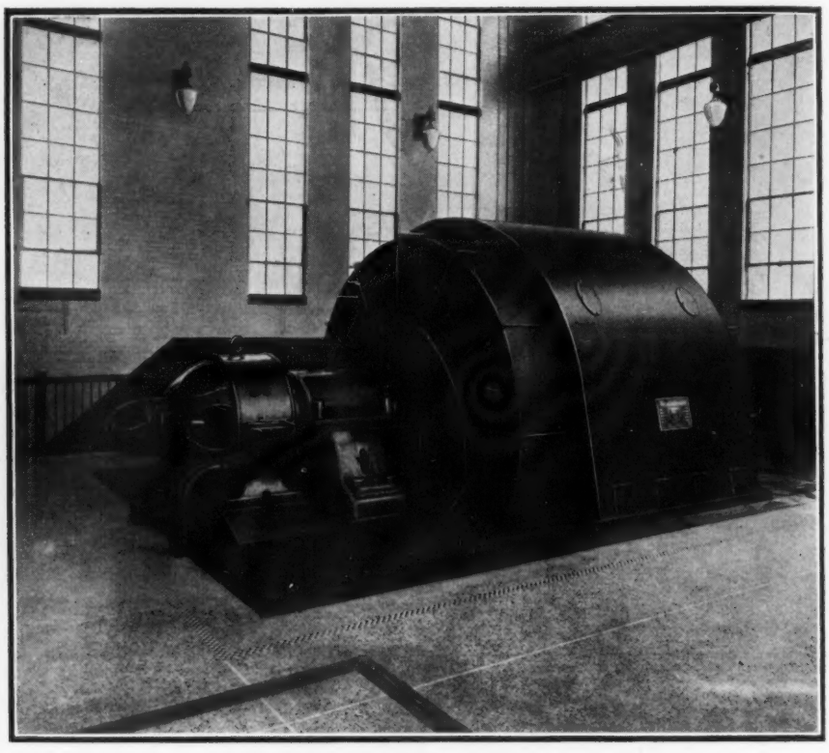
Besides the cast-aluminum clamps, there are many other excellent features of these supports which result in a device of maximum strength and electrical qualities insuring prolonged service. These features are: wet process porcelain, malleable-iron inserts and sanded porcelain surfaces for cementing. More than 1000 styles are available for 7,500, 15,000 and 25,000-volt indoor service.

Circular 1825 completely lists and describes these Type H bus-bar supports. Ask our nearest office for a copy.

WESTINGHOUSE ELECTRIC & MFG. COMPANY
EAST PITTSBURGH PENNSYLVANIA
SALES OFFICES AND SERVICE SHOPS IN ALL PRINCIPAL CITIES OF THE UNITED STATES

Westinghouse

T 30724



Service proves success

of 30,000-kv-a. 720-rpm. condensers

WESTINGHOUSE 30,000-kv-a., 720-rpm. synchronous condensers have been proved highly successful by the most reliable of all tests--actual service. Three installations have been made --the only installations in the world--and a fourth condenser of this speed and rating is now on order.

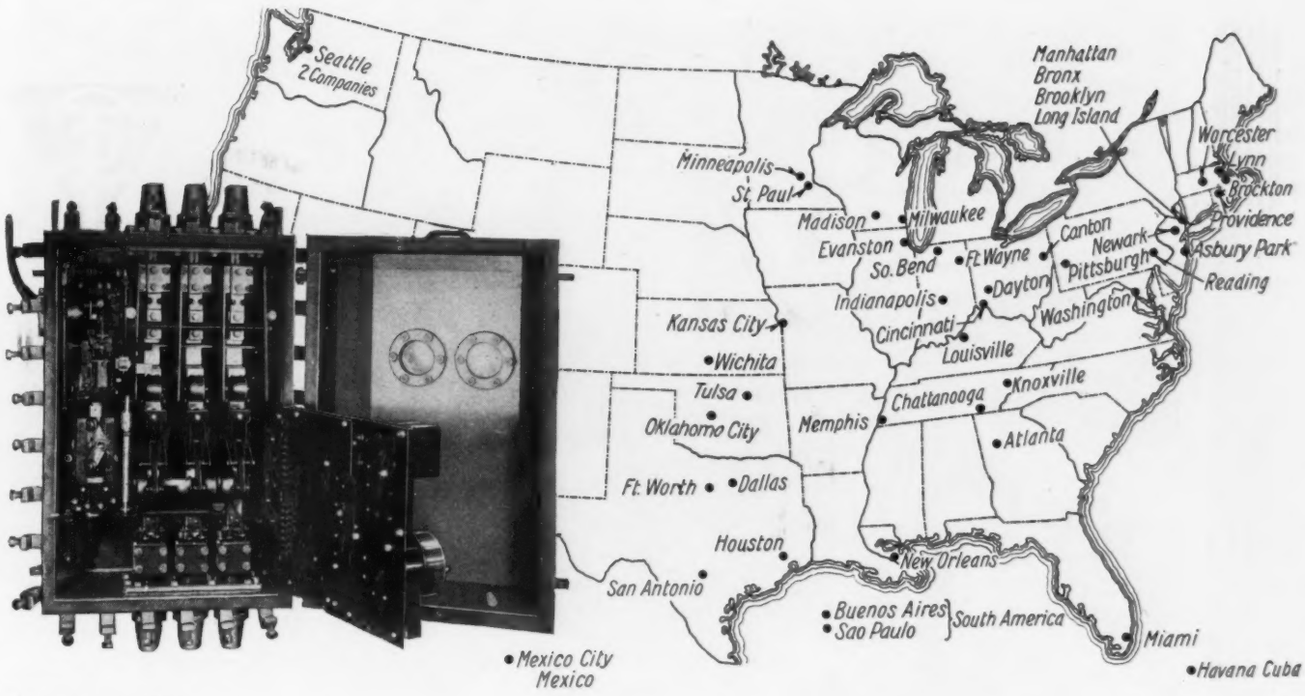
Two of these machines are giving the Philadelphia Electric Company excellent service in their Westmoreland Station and the third is successfully operating in the Garfield Avenue Station of the Consumers Power Company. In addition, the Detroit Edison Company has recently ordered a similar machine for installation in their Hart Station.

A noteworthy feature of this new design is the absence of vibration, brought about by the Westinghouse balanced design. If you wish to lower the operating cost of your synchronous condensers, ask the nearest Westinghouse office for information about these new machines.

WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY, EAST PITTSBURGH, PENNSYLVANIA
SALES OFFICES AND SERVICE SHOPS IN ALL PRINCIPAL CITIES

Westinghouse

T 30773



Subway type, 1200-ampere, CM-2 network protector. The 42 circles indicate cities using Westinghouse network protectors.

Constant Service *for* Millions in 42 Cities

CENTRAL stations in 42 cities have found it economical to furnish electric service to millions of users in the United States, Cuba, Mexico and South America through the use of Westinghouse network protectors on a-c. network systems. The widespread adoption of these protectors in the past few years is striking evidence of the success of this device for the control of low voltage a-c. network systems used in metropolitan districts.

The many advanced engineering characteristics of the CM-2 protector are responsible for the excellence of the protection it affords. Circular 1837, describing these features, can be obtained from our nearest office.

WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY
EAST PITTSBURGH PENNSYLVANIA
SALES OFFICES AND SERVICE SHOPS IN ALL PRINCIPAL CITIES

Westinghouse

T 30756

MADE TO MEASURE

for DIGGING CONDUIT TRENCH WORK

Electric light and power companies are finding the answer to their trench digging problems through the use of the Cleveland Baby Digger. On account of its compactness and extreme mobility the Baby Digger is available for more than 90% of your digging, thus eliminating practically all the slow, expensive hand-labor.

Precision-built of the finest steels obtainable and according to the most advanced engineering principles, the Baby Digger is astonishingly rugged and powerful, delivering maximum trench footage in the toughest and hardest soils, and operating at surprisingly low costs.

These features plus extreme mobility, compactness, and usability make it ideal equipment for digging conduit trenches. The extreme width of the Baby Digger is but 58 inches, thus making it useful in small limited space, and saving tremendous amount of expensive hand-labor. Its weight is but four tons and it is quickly and easily transported from location to location on its own especially built trailer, assuring you of the minimum amount of unproductive time. And the cost is but one-fourth that of hand-labor, as shown by actual statistics.

You cannot afford to be without this money saving machine, practically made to measure for your work.

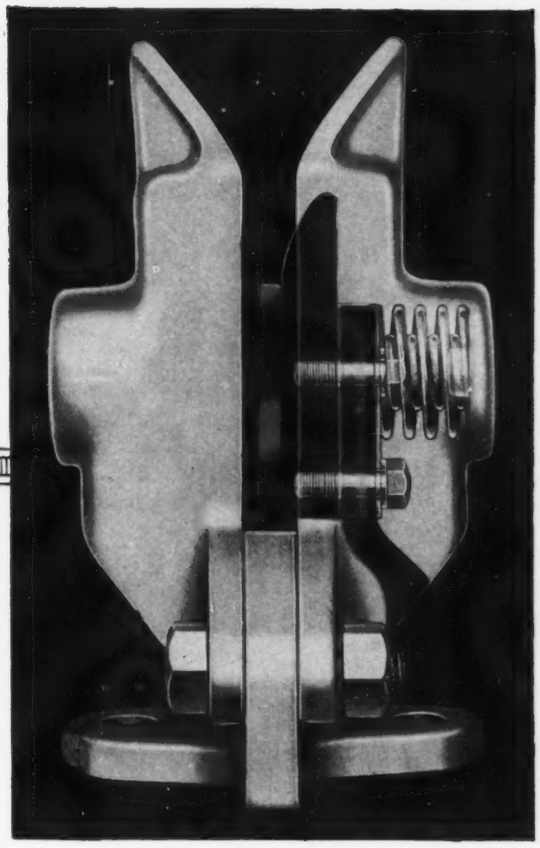
Write today for full information

THE CLEVELAND TRENCHER COMPANY

"Pioneers of the Small Trencher"

20100 St. Clair Ave., Cleveland, Ohio

THE BABY DIGGER



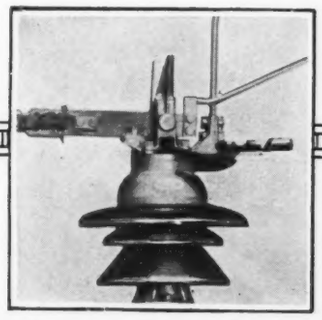
Service records *indorse* G-E line contacts

SERVICE records cannot be denied. Daily, the superiority of G-E line contacts for group-operated outdoor disconnecting switches is being proved beyond question.

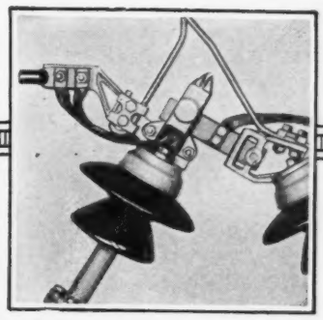
G-E line contacts require little or no maintenance and are self-adjusting. In conjunction with the blade, they produce an ice-breaking action which overcomes any sealing-in tendency. They are full-floating, a feature provided by two concentric sets of Monel-metal springs.

G-E line contacts operate under pressure, wipe into contact, and maintain clean contact surfaces. Their temperature rise is extremely low, even after long periods of service. They will withstand high short-circuit currents without pitting.

General Electric regularly supplies this type of contact on Types TA, RA, and RK disconnecting switches. For additional information, write to the nearest G-E office for a copy of publication GEA-1062.



Line contact on Type RA-1 switch



Line contact on Type TA-1 switch

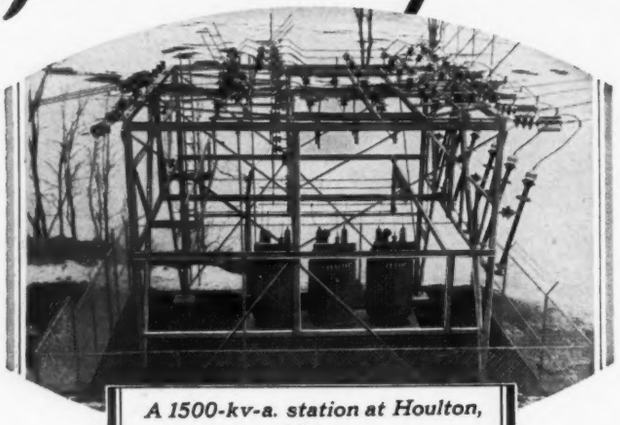
500-43

JOIN US IN THE GENERAL ELECTRIC HOUR, BROADCAST EVERY SATURDAY AT 9 P.M., E.S.T. ON A NATION-WIDE N.B.C. NETWORK

GENERAL ELECTRIC

GENERAL ELECTRIC COMPANY, SCHENECTADY, N. Y., SALES OFFICES IN PRINCIPAL CITIES

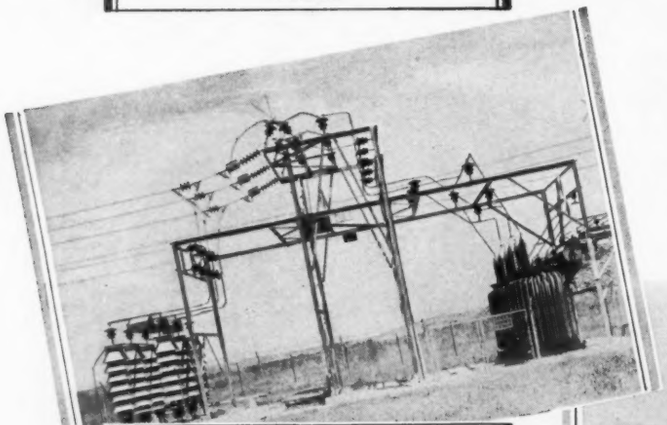
Outdoor Stations
for every service condition



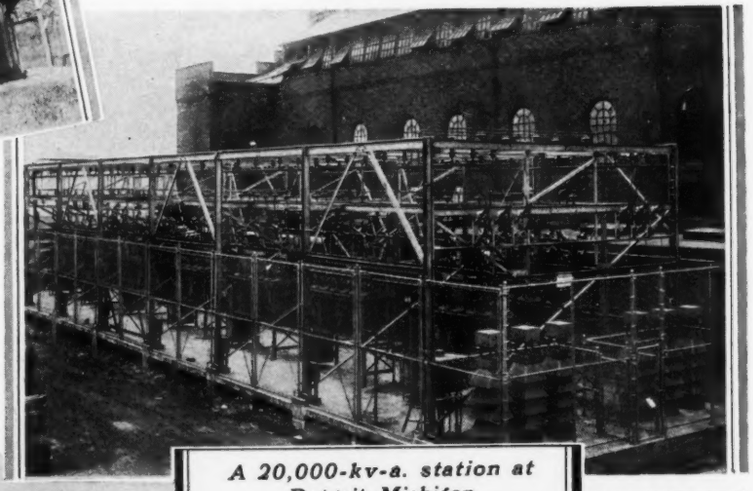
A 1500-kv-a. station at Houlton, Maine

General Electric outdoor switching equipment embodies many refinements which contribute to the high quality of these products. Research, experiment, and test, together with the knowledge acquired in the design and manufacture of equipment for every phase of power distribution, have been combined in apparatus which will meet every service condition.

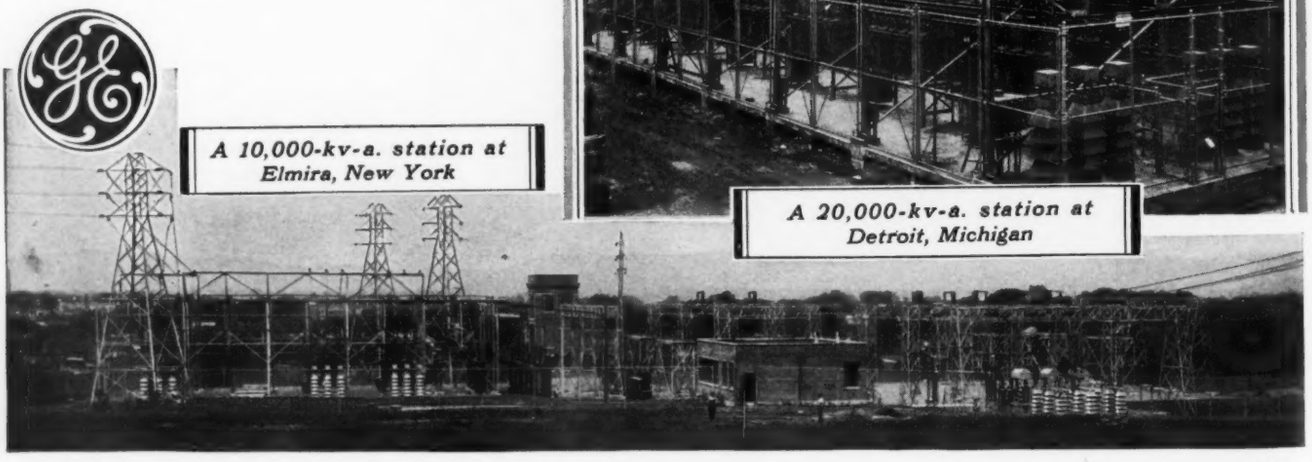
Because of mass production and quantity purchase of raw materials, prices are low. Because the complete station is designed as a unit, erection is speedily, easily effected.



A 3000-kv-a. station at Borger, Texas



A 20,000-kv-a. station at Detroit, Michigan



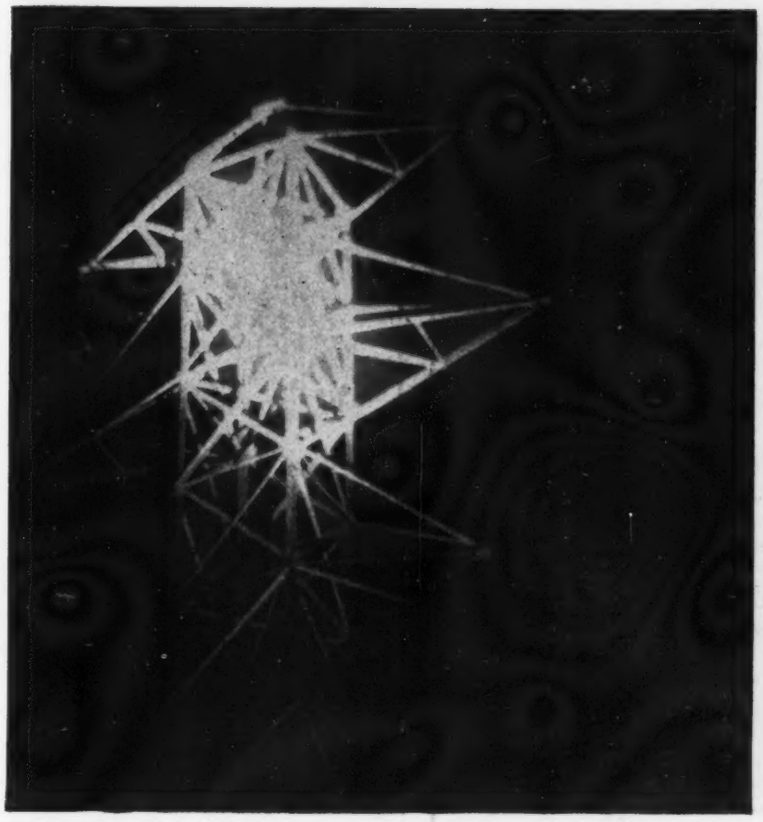
A 10,000-kv-a. station at Elmira, New York

500-36

JOIN US IN THE GENERAL ELECTRIC HOUR, BROADCAST EVERY SATURDAY AT 9 P.M., E.S.T. ON A NATION-WIDE N.B.C. NETWORK

GENERAL ELECTRIC

GENERAL ELECTRIC COMPANY, SCHENECTADY, N. Y., SALES OFFICES IN PRINCIPAL CITIES



Unretouched photograph of Beam PORTALITE illuminating top of 100-foot high tension tower.

300,000 Candle Power in Your Hand

PREPARE FOR WINTER'S STORMS

PORTALITE

The new and greatly improved PORTALITE *weighs only 13 pounds*

A portable electric searchlight—the most powerful obtainable for its weight—that will make night inspections and emergency repairs on overhead cross country high tension lines as safe as in daylight.

Both Beam or Flood Type will burn 2½ to 3½ hours, or 5 to 7 hours with smaller-size bulb. Equipped with special non-spillable 15 ampere hour storage battery and adjustable position lite bracket. Beam type will project rays over a mile. Flood type, for manhole and ditch work, and for emergency station work, will brilliantly illuminate 30,000 square feet at a distance of only 50 feet.

The PORTALITE is also supplied with fittings for mounting as a spotlight—called the BEAMOLITE. The BEAMOLITE is invaluable for working on lines which can be approached from the street.

These lights pay for themselves many times over by the time saved in locating and repairing line trouble at night.

One of the large eastern utilities wrote in their com pany magazine—for their associated companies:

"We have used the Portalite for locating trouble on our lines for the last year and a half, and they have worked out very satisfactorily. Owing to the fact that they are so extremely light in weight, our linemen can carry them anywhere. Previous to using the Portalite we used various devices for this kind of work, but we were unable to find anything that would furnish the necessary light without having so much weight that it was impossible for our men to carry it, except for short distances.

We believe that this device is the only one on the market that is practical for this kind of work."

Mr. Whitcomb, of one of the electric light and power companies, says:

"Before we bought the Portalite, we used the automobile spotlight which has its limitations in service. For locating trouble on the high line, over which the automobile cannot be driven, we had nothing with which to light up the line. For instance, during a severe storm last winter in which some two feet of snow fell, service on the high line was interrupted. The automobile couldn't be used. We patrolled the line all night in an endeavor to find the break. When daylight came, we found we had passed it four times. The few times we have had occasion to use the light this summer, I feel has already made it pay for itself."

13 years of Faithful Service

THE PORTALITE COMPANY

1109 Massachusetts Ave., Cambridge, Mass.

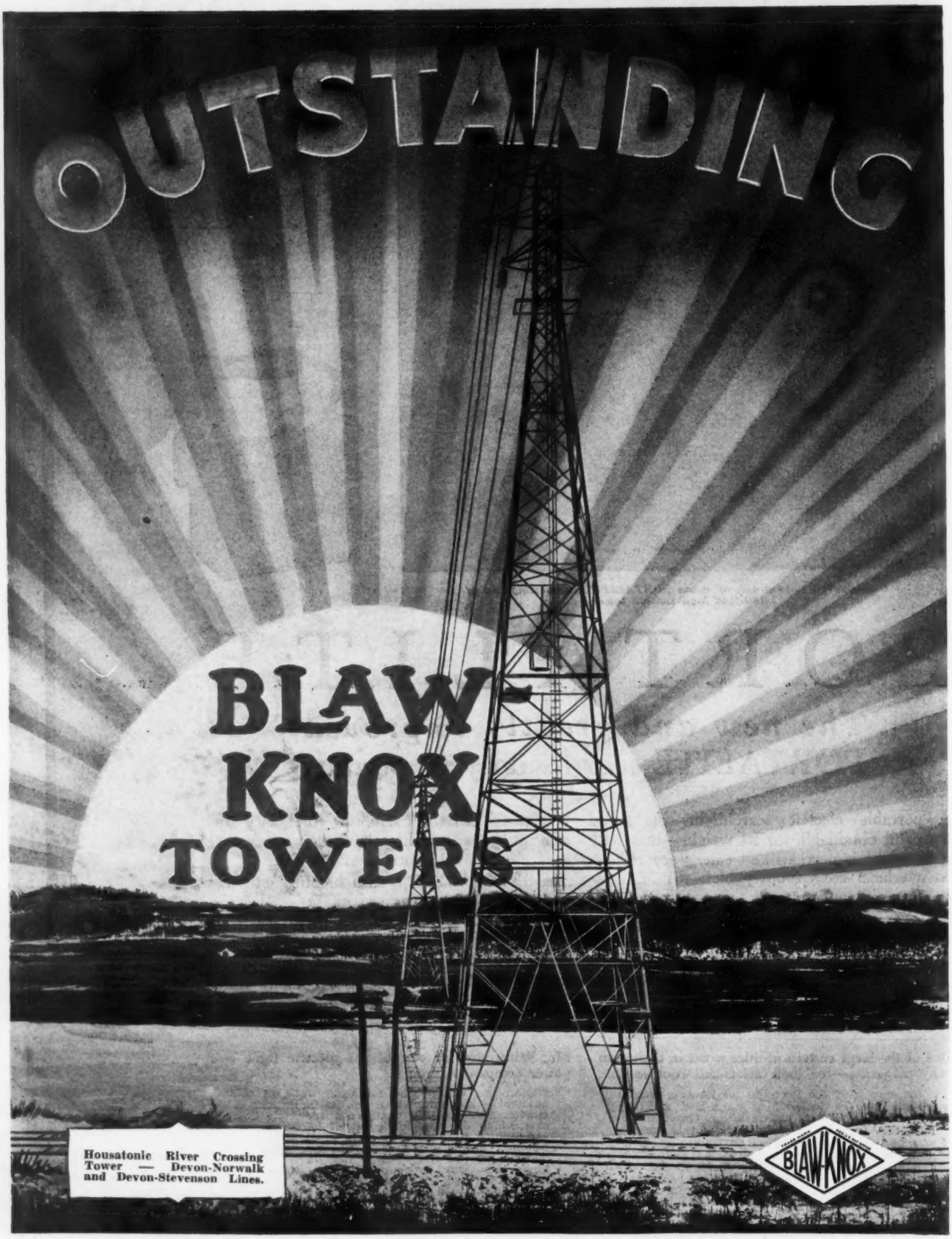
Please send our company BEAM ☐ PORTALITE ☐ FLOOD ☐ for tryout. At end of 10 days we will either send confirming order or return lite.

Company .....

Address .....

State ..... Official Title .....

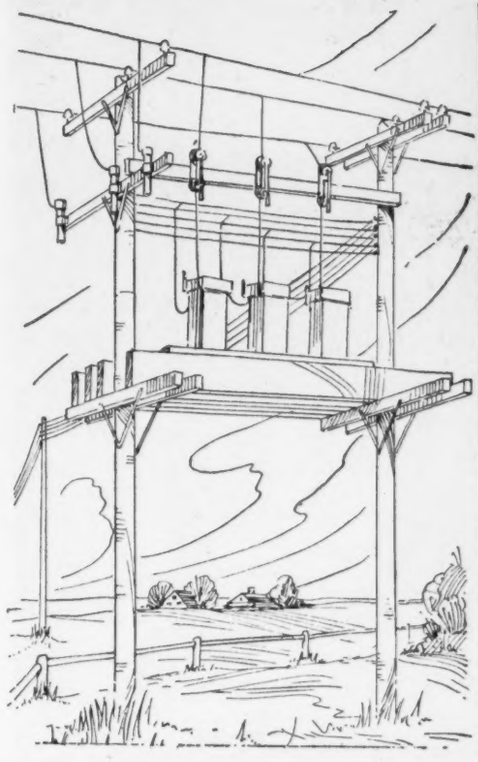
Send Literature ☐

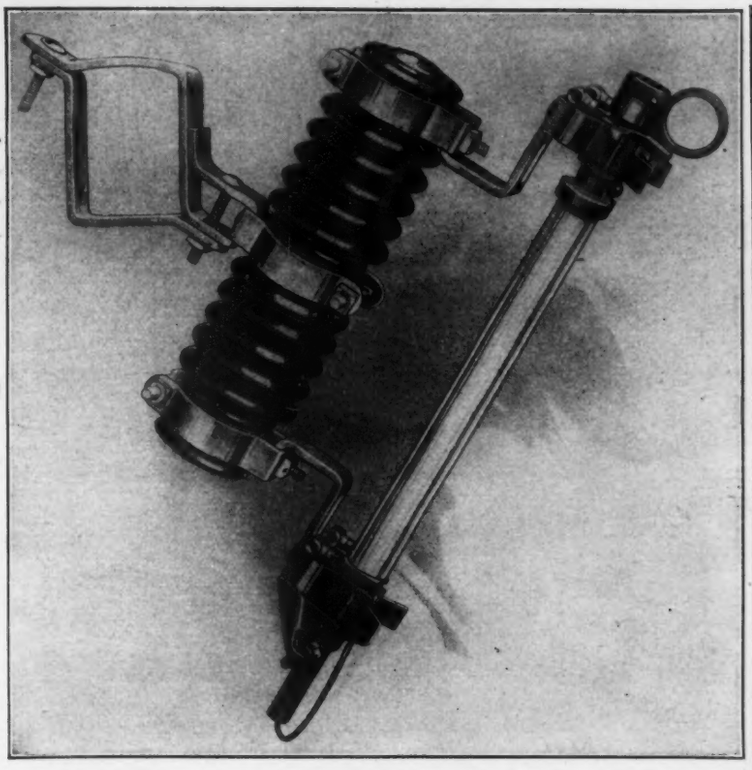


BLAW-KNOX CO., PITTSBURGH, PA.

TOWERS POLES · SUB STATIONS · RADIO TOWERS · CATENARY SUPPORTS · MALONE ANCHORS

PERFORMANCE —





Actual Service

Actual service is the "Approval Stamp" for any product. Kearney Switching Equipment is rapidly being adopted nationally as standard by performance in actual service.

Kearney Products

Screw Type Anchors, Hi-Tension 4-in-1 Expansion Anchors, Solderless Service Connectors, Double Duty Fuse and Disconnect Cut-outs, Fuse Pullers, Expulsion Porcelain Plug Cut-outs, Guy Wire Clips, Sleeve Twisters with interchangeable dies, Economy Cable Clamps, C-G Hot-Tap Clamps, "No-Serve" Yokes, Live Line Tools and Accessories.

Dependable Fuse Switches

Rural line construction requires the use of popular priced switching equipment which has ample safety factors, and high quality materials. Kearney One-Piece Porcelain Switching Equipment has been designed to meet these needs. Initial installation costs are low, and maintenance costs are equally so. Insulators are fog type, one-piece porcelain with petticoats; cartridges are equipped with a positive lock; contacts are either full-floating, or stamped, as specified; crossarm hanger is universal, being adjustable for use on any standard size crossarm.

Bulletin No. 312, containing complete information on all Kearney Switching Equipment, will be sent on request.

JAMES R. KEARNEY CORPORATION
4224-32 CLAYTON AVE. ST. LOUIS, MO.
FACTORIES: St. Louis, Kansas City, Mo., Taylorville, Illinois

A KEARNEY PRODUCT

BEING ADOPTED NATIONALLY AS STANDARD EQUIPMENT

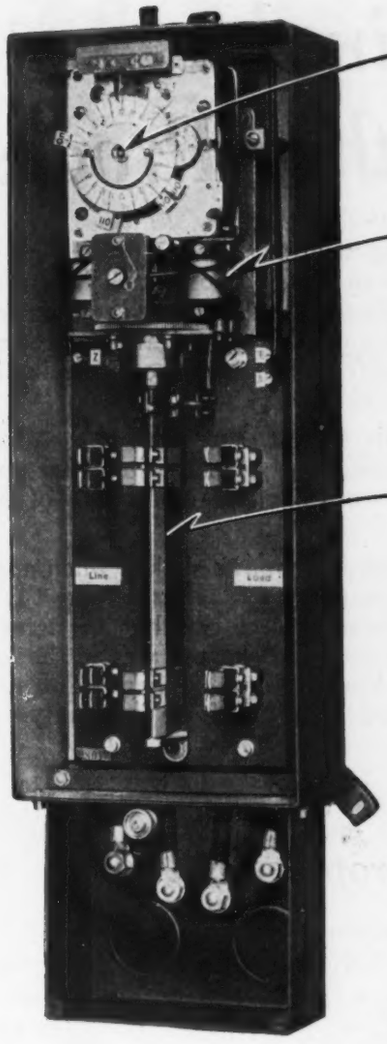
Prompt shipment of highest quality creosoted pine poles can be made from our large supply of poles ready for immediate framing . . . . Extra large poles and specially framed poles ready for the hole upon arrival can be furnished on short notice.

2IC9
The International Dating Nail

Thirty years of service and still strong prove the economy of International quality.

International Creosoting & Construction Co.
General Office: Galveston, Texas

International Creosoted Yellow Pine Poles


1
On and off operation settings — easily adjusted or inspected.
2
Universal motor of conventional design—quick observance—no complicated transmission.
3
Rotary main switch—quick acting — high pressure — self-wiping contacts — multipole single and double - throw combinations.
Line
Load

Compare

their simplicity

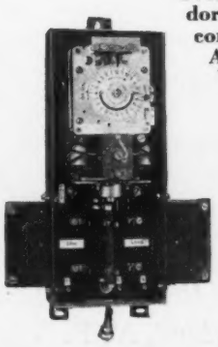
with any self-winding time switch in the world!

Wherever and whenever SAUTER Time Switches are subjected to thorough and critical ANALYSIS in comparison with any Time Switches in the world— SAUTERS SELL THEMSELVES!

. . . because their simplicity of design and construction is an actual guarantee of accurate and uninterrupted operation under every condition of service.

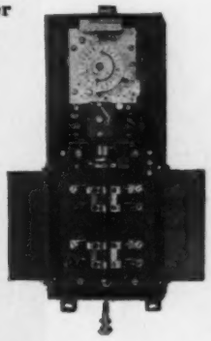
Whenever and wherever SAUTER Time Switches are subjected to thorough and critical TESTS in actual service they CLINCH the sale they originally made. Their service record is unexcelled . . . because they always outperform the service their design and construction originally assured!

Over a hundred thousand SAUTERS have been in use for many years. . . endorsed by foremost public service corporations, electric light and power companies, electric sign manufacturers, electrical contractors. . . AND the United States Government. Used on either A.C. or D.C. Write for complete illustrated catalog.



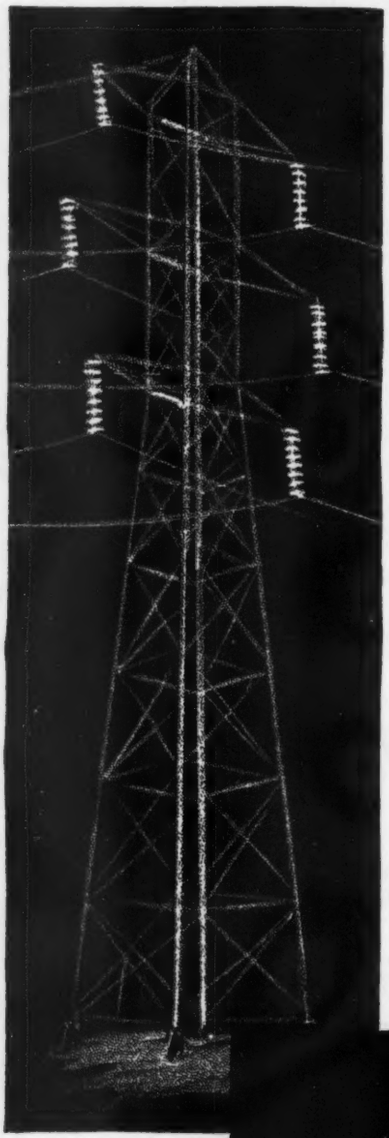
SAUTER

Time Switches



R. W. CRAMER & CO., INC., 136 Liberty St., New York

A Uniformity Obtainable Through No Other Process!



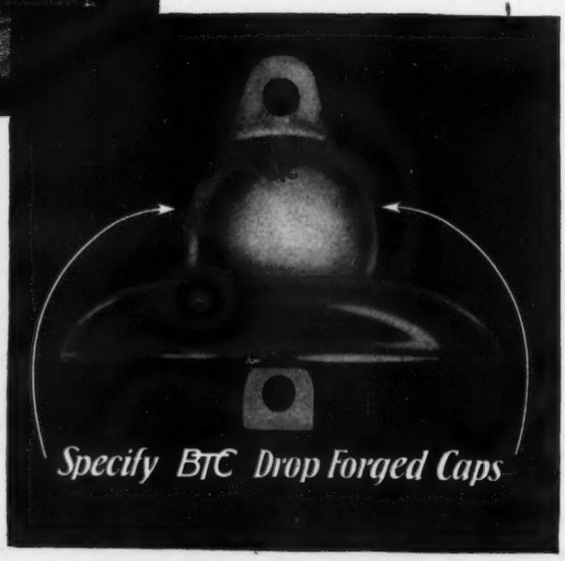
HOMER in his myths mentions the art of forging swords. Much praise is given to the swordsmith in the tales of King Arthur and his round table. For these ancients discovered that heating and hammering the metal produced a pliant, fine textured weapon of uniformity, capable of retaining its keen edge over a long period of time.

To-day modern industry places that same faith in the drop forging. Passing down from generation to generation it has improved until to-day it is a prime factor where uniformity of metal is required.

And this same solid argument cannot be shaken when applied to the caps for high tension suspension type insulators. Trial and error is a sure way of discovering weak caps but it is a costly old-fashioned method. The better and cheaper way in the long run is to specify BTC Drop Forged Caps. There is no need for further testing for they are 100% uniform in quality—proven over years of testing.

Why a Drop Forged Cap?

1. They are 100% uniform in quality.
2. They are made of Copper-Bearing Steel to resist corrosion.
3. Their superior strength has been proven by many tests.
4. They can be heat treated to a maximum strength with minimum weight.
5. They are free from hidden defects or concealed flaws.



Write for our booklets explaining the process of drop forging and research into corrosion of iron and steel

Engineers are Considering These Facts in Specifications for Power Line Contracts

The
Brewer-Titchener Corp.
Cortland, N. Y.

THIS BOOK!

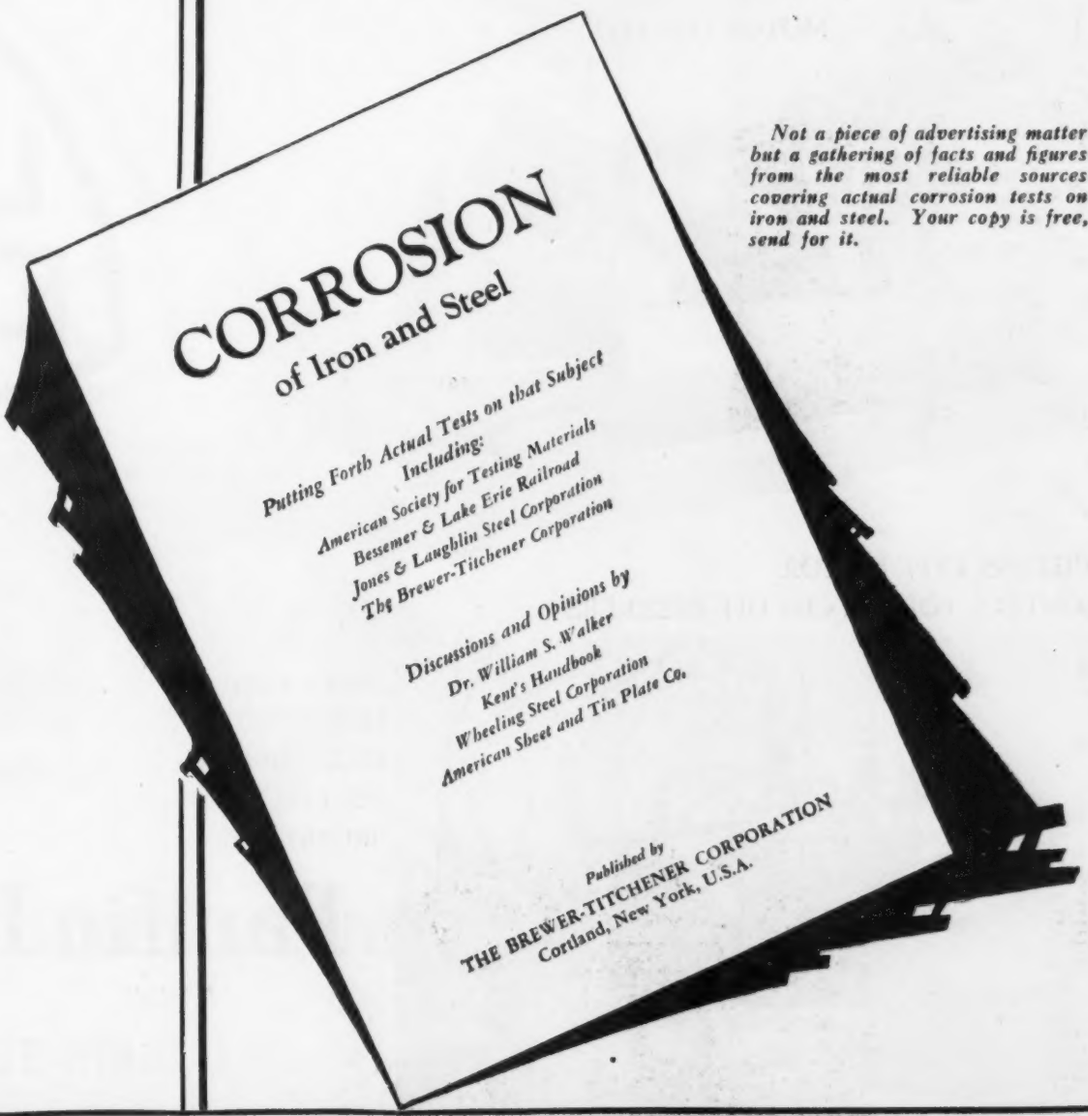
Was Printed for Your Benefit

FOR many years commercial users of iron and steel have been looking for a suitable metal to withstand the ravages of corrosion due to atmospheric conditions. We therefore find research work in progress to obtain actual facts and figures on that subject.

Tests have been, and are being made by large corporations, individuals and organizations to find a commercial steel or iron that once in use will result in the savings of thousands of dollars now going to the coffers of this nuisance.

Without choice or favor we have gathered material on these tests and published them in the form of a brief, stating the procedure and results along with discussions by prominent men dealing with the subject. Every person who is interested in this problem may have the book "Corrosion" by writing to us for it.

THE BREWER-TITCHENER CORPORATION
Cortland, New York



Not a piece of advertising matter but a gathering of facts and figures from the most reliable sources covering actual corrosion tests on iron and steel. Your copy is free, send for it.

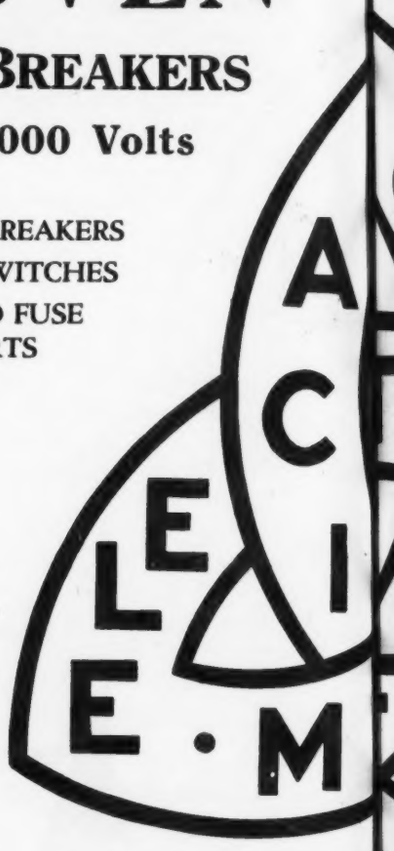
15,000 VOLT OIL CIRCUIT BREAKER AND MS-2 MOTOR CONTROL

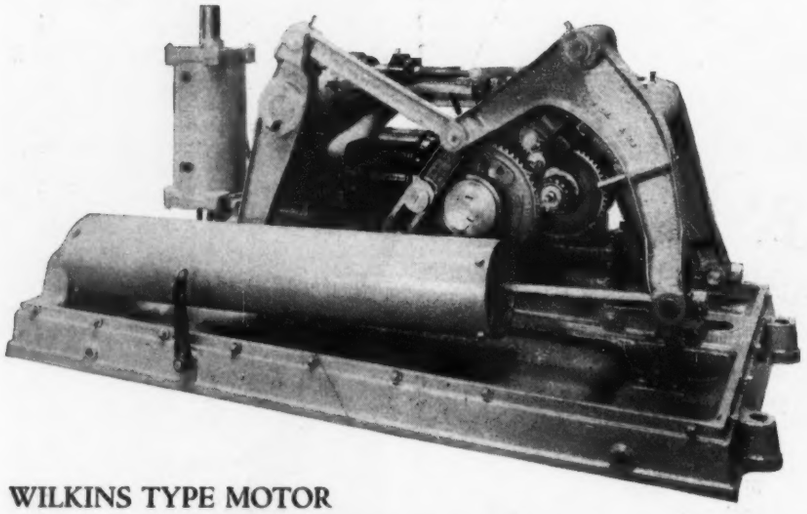
PACIFIC PROVEN

OIL CIRCUIT BREAKERS

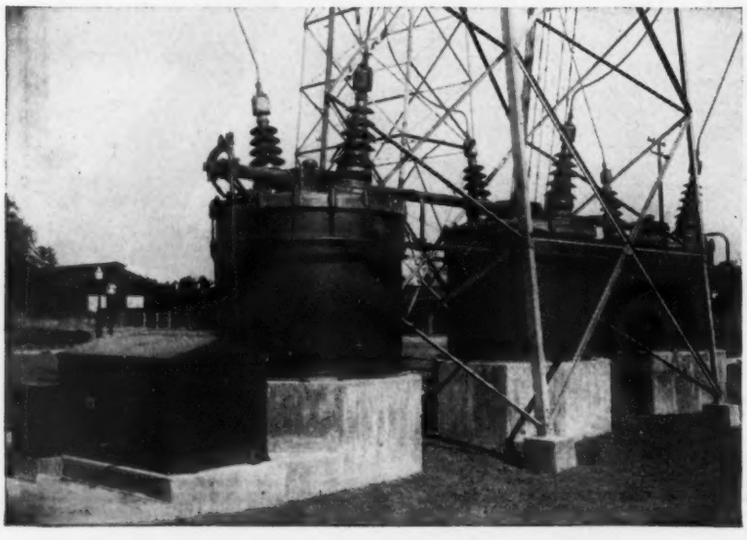
15,000 to 132,000 Volts

OIL CIRCUIT BREAKERS
AIR BREAK SWITCHES
FUSES AND FUSE SUPPORTS

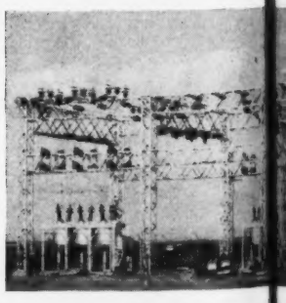




WILKINS TYPE MOTOR CONTROL FOR OIL CIRCUIT BREAKERS



110,000 VOLT HORIZONTAL MULTI-BREAK OIL CIRCUIT BREAKER



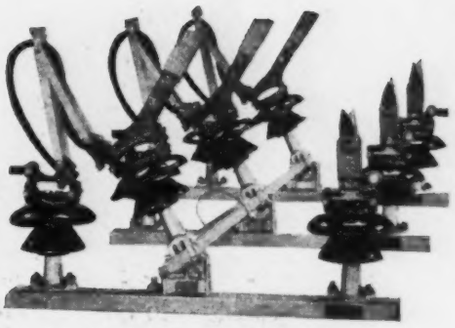
Complete Swi
and Ste

Pacific Electri

5815 THIRD STREE

Representati

ELECTRIC EQUIPMENT



THE FIRST SQUARE SHAFT, ROCKER TYPE AIR BREAK SWITCH

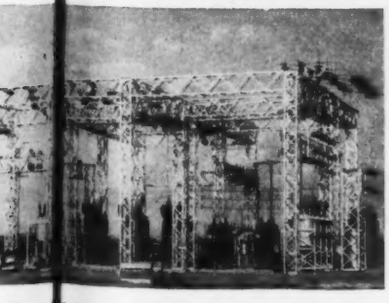
AIR BREAK SWITCHES

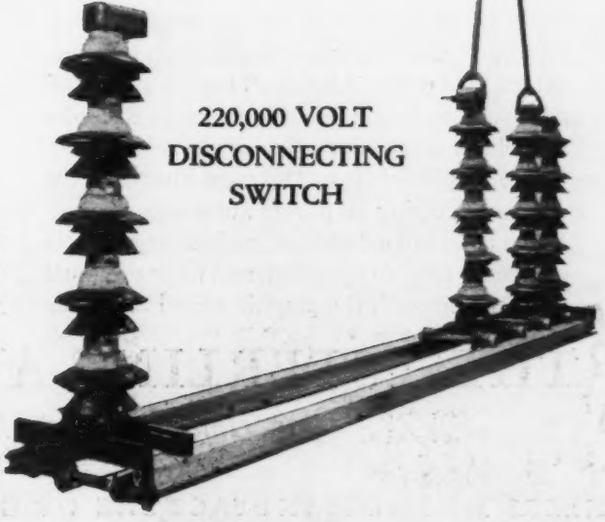
6,600 to 220,000 Volts

STEEL STRUCTURES
BUS SUPPORTS
CHOKE COILS
REGULATOR HEADS

BAUM TYPE, SINGLE AND DOUBLE BREAK AIR BREAK SWITCHES

PACIFIC ELECTRIC FUSE SUPPORTS AND FUSES





220,000 VOLT DISCONNECTING SWITCH

Swi hing Equipment
Ste Structures

ri Mfg. Corporation.

REE SAN FRANCISCO, CALIF.
cati in Principal Cities

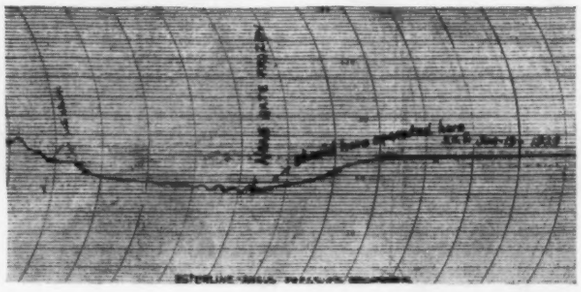
Esterline-Angus engineers welcome the opportunity to advise power plant men on the unusual, as well as the common usages of graphic instruments. May we be of service to you?

DANGER *from Freezing Avoided* with Graphic Record . . AT TUMWATER PLANT OF GREAT NORTHERN RAILWAY

AT THE Tumwater Plant of the Great Northern Railway a penstock two miles in length carries water from high in the mountains to the power house. Should freezing occur in the intake of the line a terriffic vacuum would cause collapse of the penstock lower down.

Realizing this possibility, the engineers in charge installed an automatic relay in the line to throw off the load at the power house when the pressure of the water should drop to a predetermined point of safety. They also installed an Esterline-Angus Graphic Pressure Recorder as a check on the operation of the relay.

The graphic chart on this page illustrates the danger of relying on purely automatic devices. When the head gates froze, on January 4th, *the relay was "late" in operation*, and while no actual damage occurred, the graphic record served as



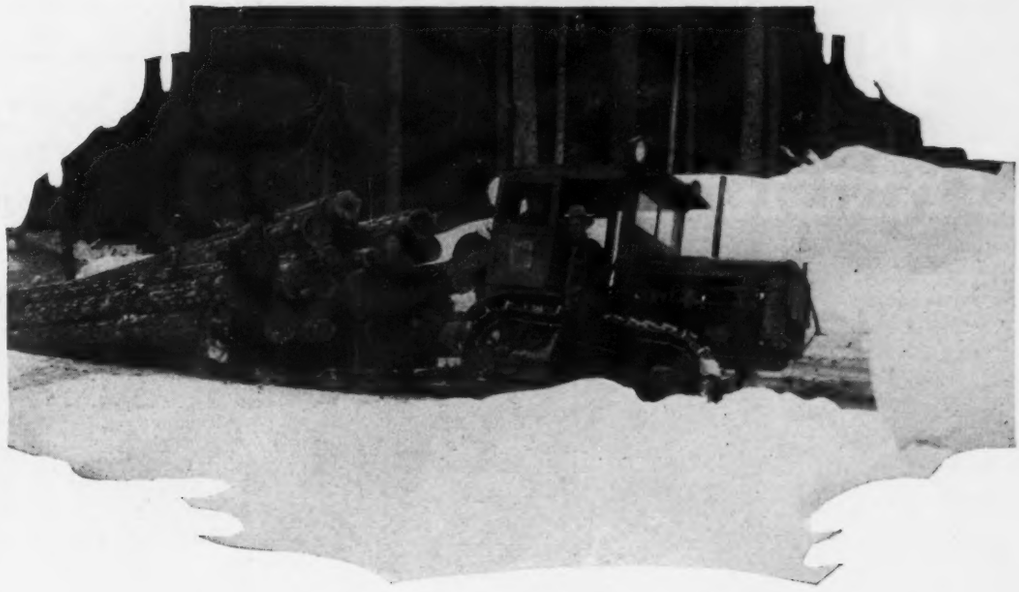
a guide for re-setting the relay to insure protection.

The wide variety of application of graphic recording instruments for the protection of valuable assets is proven again in this authentic instance. Your problem may be, and probably is, an entirely different one. Perhaps you have never thought of graphic instruments as the solution.

THE ESTERLINE-ANGUS COMPANY

Indianapolis, Indiana, U. S. A.

PIONEERS IN THE MANUFACTURE OF GRAPHIC RECORDING INSTRUMENTS



"SERVICE IS THE THING"

Out of the forests Carney takes them by horse, truck, flume, tractor, water and train

Here comes a tractor load of Carney poles out of the snow covered forests. It contains 35 poles of 40, 45, and 50 foot lengths, freshly cut and weighs about 20 tons. Where water is available it is more simple to get the poles out of the forests. Otherwise various means are used, the tractor being one of them. We are well equipped, however, to meet every situation and keep the poles coming out of the forests, the year round so we are assured of an ample supply of seasoned poles at all times.

PENTREX
Guarantees 3/8 or 1/2 inch penetration on every pole.

B. J. CARNEY & CO.

Main Offices:

100 North 7th St., Minneapolis
Sicamous, B. C.
Enderby, B. C.
Peyton Bldg., Spokane, Wash.

Treating Plants:

Minneapolis
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General Sales Offices:

237 Commercial Tr. Bldg., Philadelphia
115 So. Dearborn St., Chicago
214 Old South Bldg., Boston
701 Midland Bldg., Kansas City, Mo.
1315 American Bldg., Cincinnati, Ohio
839 Oliver Bldg., Pittsburgh

Carney

Western Red Cedar Poles

Wagner Transformers

Wagner has built transformers about forty years and introduced many of the basic improvements. The Wagner line is complete and thoroughly up to the requirements of modern power service. Wagner Transformers complete Wagner Power Service to Industry.

Write for complete details of Wagner Distribution, Power and Subway Type Transformers.

Literature on Request

WAGNER ELECTRIC CORPORATION
6400 Plymouth Avenue, St. Louis, U. S. A.

Wagner Sales Offices & Service Stations in 25 Principal Cities

Products: **FANS . . . . . Desk, Wall and Ceiling**
TRANSFORMERS . . . Power, Distribution and Instrument
MOTORS . . . Single-phase, Polyphase and Direct Current

Wagner ... quality

The Complete Line of

PORCELAIN HOUSED

MATTHEWS FUSWITCHES

and DISCONNECTING SWITCHES

Genuine Wet Process Porcelain Housing

No Live Parts on Door

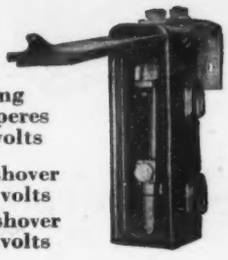
Double Tube Matthews Cartridge

Flat Surface Pressure Type Contacts

No Radio Interference

THESE three Matthews Fuswitches have been developed to provide a small group of wet process, porcelain housed Fuswitches, with the exclusive Matthews features, to meet every need from 150 amperes—7500/12500 Y volts—down. Every duty that they will be expected to fulfill has been anticipated by Matthews Engineers. Safety, compactness and dependability are the outstanding characteristics. These Fuswitches have been thoroughly tested for rupturing capacity and will safely clear 25 times their Delta rating. Each is quickly converted into a Disconnecting Switch by the substitution of a disconnecting blade for the cartridge. Try them on your lines. W. N. MATTHEWS CORPORATION—Engineers and Manufacturers—3702 Forest Park Boulevard—St. Louis, Mo.

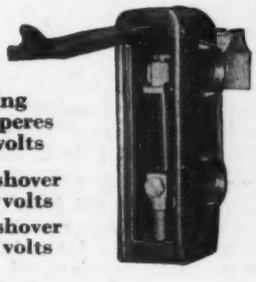
the 600



rating
60 amperes
5000 volts

dry flashover
48,000 volts
wet flashover
22,000 volts

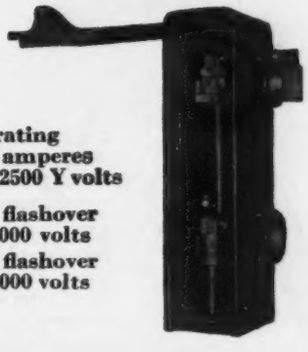
the 800



rating
60 amperes
7500 volts

dry flashover
48,000 volts
wet flashover
28,500 volts

the 900



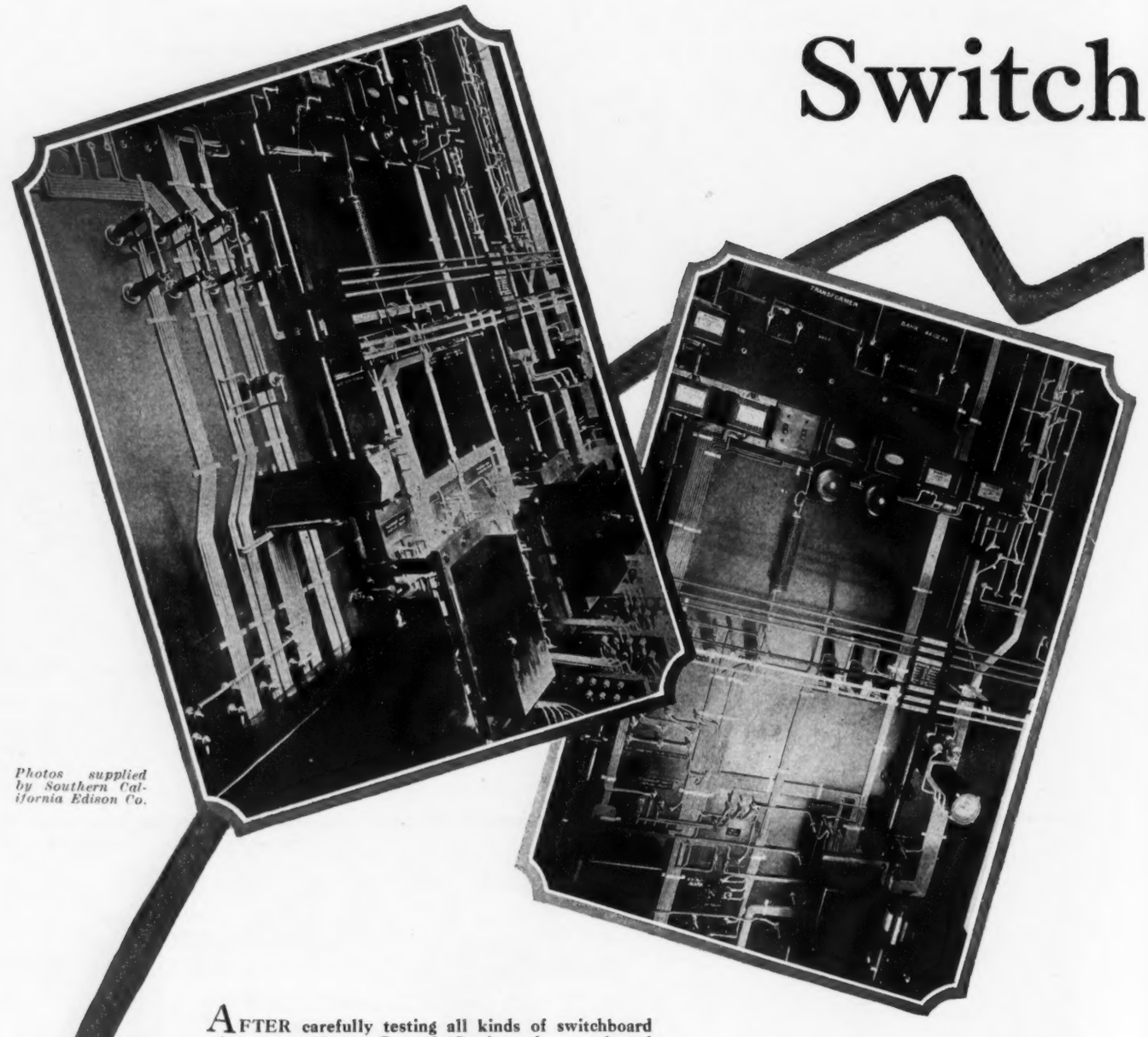
rating
150 amperes
7500/12500 Y volts

dry flashover
53,000 volts
wet flashover
30,000 volts

ROCK

—*the asbestos*

Switch



Photos supplied by Southern California Edison Co.

AFTER carefully testing all kinds of switchboard wire, many large Central Stations have selected Rockbestos Switchboard Wire as standard for all their switchboard work.

All over the country, Central Stations and large industrial plants have found that Rockbestos Switchboard Wire meets perfectly every need for switchboard service and have consequently standardized on its use.

BESTOS

insulated wire

board Wire

If this were just ordinary switchboard wire, we wouldn't use two pages to tell you about it.

But, it is Rockbestos Switchboard Wire and it is far from ordinary.

It is an exceptional wire in many ways—just those ways that you might specify for the ideal wire.

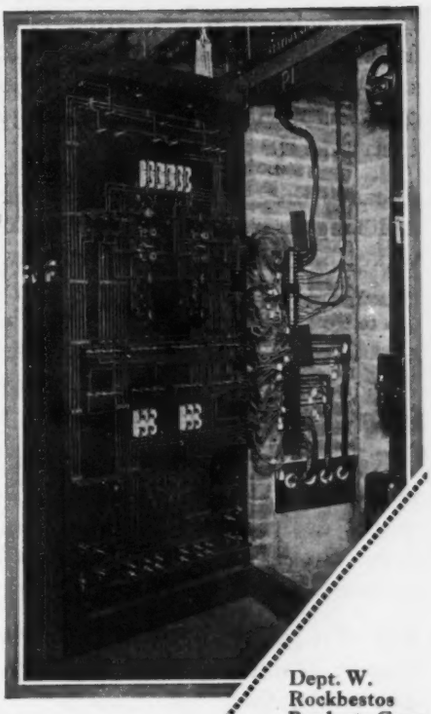
In the first place, it is built with Rockbestos insulation—there is nothing better.

Heat, flame or moisture will not affect it.

The covering is tough and so laid on that you can bend it in any form or even hammer it without breaking or cracking, and still maintain its dielectric strength.

Best of all, when your job is done with Rockbestos Switchboard Wire—it looks fine and you are pleased.

Samples will be sent for your inspection and test. Use this coupon.



An interesting application of switchboard wire by Toronto Hydro Elec. System.

Dept. W.
Rockbestos Products Corp.

Please send samples of Switchboard wire for test.

Name .....

Title .....

Company .....

Address .....

ROCKBESTOS PRODUCTS CORPORATION

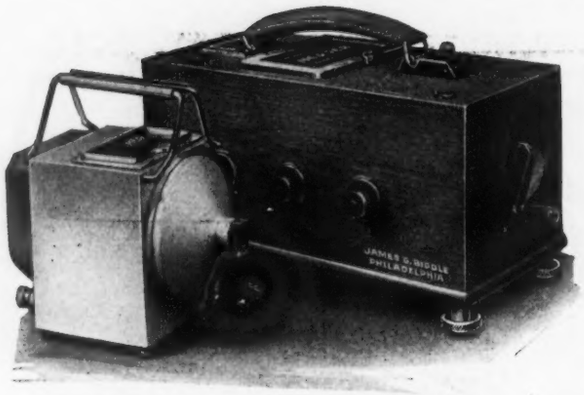
NEW HAVEN, CONN.

942 Grand Central Term. Bldg., New York 903 Clark Bldg., Pittsburgh, Pa 224 Madison Term. Bldg., Chicago

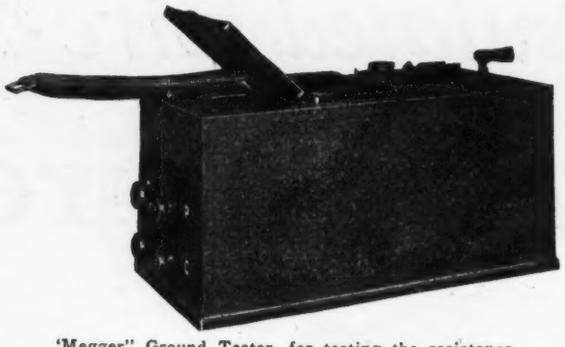
On the Pacific Coast – Anaconda Wire & Cable Co.

The World Famous "MEGGER" INSTRUMENTS

TRADE MARK REGISTERED U.S. PAT. OFF.



The "Meg" Insulation Tester and a High-Range "Megger" Testing Set



"Megger" Ground Tester, for testing the resistance to earth of ground connections

. . . for testing insulation resistance

A "MEGGER" test for resistance of electrical insulation is the final authority wherever such tests are made. Why do engineers and practical men alike prefer "Megger" Instruments?

Because they read directly in ohms and megohms, with no calculations whatever. Because they are simple in construction, in set-up, and in operation. Because accuracy is not affected by age or excessive use. They are built to endure, and to perform perfectly while enduring.

"Megger" Instruments are built in ranges up to 10,000 megohms. Tell us the desired range, if you can, or name the general class of testing contemplated.

Ask for a copy of our 80-page Pocket Manual of "Megger" Practice and Catalog No. 1205-W.

BIDDLE SPECIALTIES

"MEGGER" & "BRIDGE-MEGGER" INSULATION TESTING SETS
"MEG" & "SUPER-MEG" INSULATION TESTERS
"MEGGER" GROUND TESTERS
"MEGGER" & "MEG" DIRECT-READING OHMMETERS

"DUCTER" LOW RESISTANCE TESTING SETS
"DIONIC" WATER TESTER

"FRAHM" FREQUENCY METERS
"FRAHM" TACHOMETERS

"JAGABI" SPEED-MEASURING INSTRUMENTS

"JAGABI" RHEOSTATS
"JAGABI" VIBROMETERS

SIEMENS-BLONDEL OSCILLOGRAPH
WOLFF PRECISION POTENTIOMETERS
SCIENTIFIC APPARATUS

. . . for testing ground connections

BUILT to the same standards of quality which have made the older "Megger" Testing Sets so justly famous, the "Megger" Ground Tester incorporates the greatest feature of all "Megger" Instruments—direct-reading scale in ohms.

Operator merely drives reference grounds in usual manner, connects to the "Megger" Ground Tester—then turns the crank and reads the scale. That is all there is to it.

Accurate, self-contained, portable and extremely durable for an instrument so sensitive.

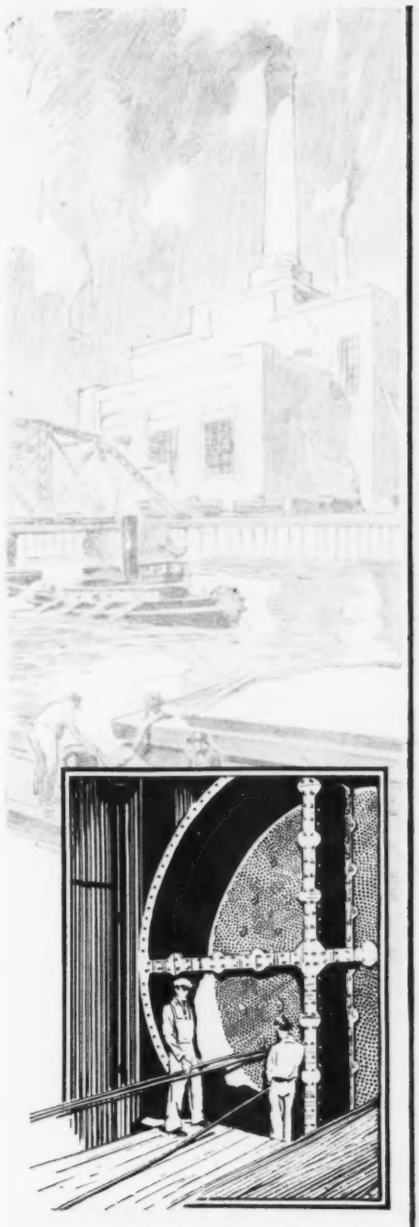
The consistent, rapid and accurate results with this instrument are saving time and money for utility and operating companies in all parts of the country.

Send for Bulletins 1180-W and 1185-W.

JAMES G. BIDDLE

ELECTRICAL INSTRUMENTS

1211-13 Arch St. Philadelphia



Anaconda Condenser Tubes being installed in Condenser No. 4—Hudson Avenue Station, Brooklyn Edison Company.

ANACONDA
from mine to consumer

Engineers are invited to consider the advantages of Everdur nuts and bolts for fastening Condenser Head Plates. Everdur, an exclusively Anaconda product is a Copper-Manganese-Silicon Alloy combining the strength of steel with unusual resistance to corrosion. Described in Publication E-2.

There is more to

Anaconda Condenser Tubes

than meeting the specifications

SPECIFICATIONS are valuable guides to quality but they alone cannot insure the highest technical standards of manufacture which add extra years of service.

The highest quality of Anaconda Condenser Tubes is safeguarded by the exclusive use of Anaconda mined, smelted and electrolytically refined Copper and Zinc, each guaranteed 99.9% pure as well as by the technical knowledge and manufacturing skill developed by The American Brass Company in over a century's experience in the manufacture of Copper, Brass and Bronze products.

Anaconda Condenser Tubes are furnished in all standard alloys. Admiralty Alloy is recommended for sea-water or polluted fresh water; 70—30 Brass is suitable for clean fresh water and Muntz Metal Tubes may be used under favorable conditions. Ambrac, an exclusively Anaconda product is offered for unusually severe service.

Anaconda Publications B2, an authoritative discussion with specifications, contains informative data on Condenser Tubes and Head Plates. Copies will be sent without obligation, to Engineers upon request.

THE AMERICAN BRASS COMPANY
General Offices: Waterbury, Connecticut
Offices and Agencies located in all the Principal Cities
Canadian Mill: ANACONDA AMERICAN BRASS LTD.
New Toronto, Ontario

ANACONDA
COPPER ANACONDA BRASS

Explanation No. 8

of the factors necessary to an economic superheater installation.

Be sure your superheater offers

PROPER distribution of gases

The location and proportions of the superheater should be such as to keep the gases of combustion uniformly distributed and at constant velocity.

By using small diameter bare tubing correctly proportioned in the boiler, the gases are split up thoroughly and a very even distribution of the gases passing the superheater is afforded.

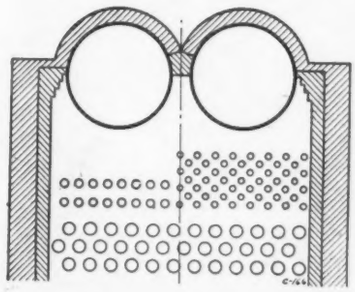
In this way more heat is abstracted from the gases because of the large proportion of effective heating surface in the gas area. Maximum efficiency of the transfer of heat from the gases to the steam, without unduly obstructing the passage of the gases, can be best obtained in this way.

How this is achieved:

In designing Elesco superheaters extreme care is exercised in placing the units so that they are swept evenly by all the gases of combustion. Because the units comprise small diameter tubes the mean distance of the particles of gas from the heating surface is kept at a minimum and more heat is therefore absorbed. This means maximum efficiency of heat transfer from the gases to the steam.

While the units are arranged so as to split up the gases and proportion them evenly in their flow past the superheating surfaces, the use of small diameter tubing for superheater units avoids any undue draft loss at high boiler capacities. This is demonstrated graphically at the left. This illustration shows a comparison between a superheater with large diameter tubing and one with smaller diameter tubing. The other illustration below shows a typical arrangement of Elesco superheater units in the tube bank of a semi-vertical boiler, which is known as the intertube arrangement.

Even distribution of gases also gives the least opportunity for adhesion of dust and soot; consequently a constant high rate of heat transfer and high uniform superheat is maintained.



Compare the Gas Distribution in These Two Superheaters. Small Tube Elesco Superheater (Right), Large Tube Superheater (Left).

Elesco Intertube Superheater in Semi-vertical Boiler.

The units break up the flow of gases, so they come into better contact with the boiler tubes. The gas streams are diverted just as in the staggered tube arrangement of horizontal boilers, while draft loss is held at a minimum, and the heat transfer from gases to boiler tubes is increased. Result: lower exit gas temperature and correspondingly higher boiler efficiency.

THE SUPERHEATER COMPANY

17 East 42nd Street, NEW YORK

Peoples Gas Building
CHICAGO

ELESCO

Union Trust Building
PITTSBURGH

CANADA: The Superheater Company, Limited, Montreal

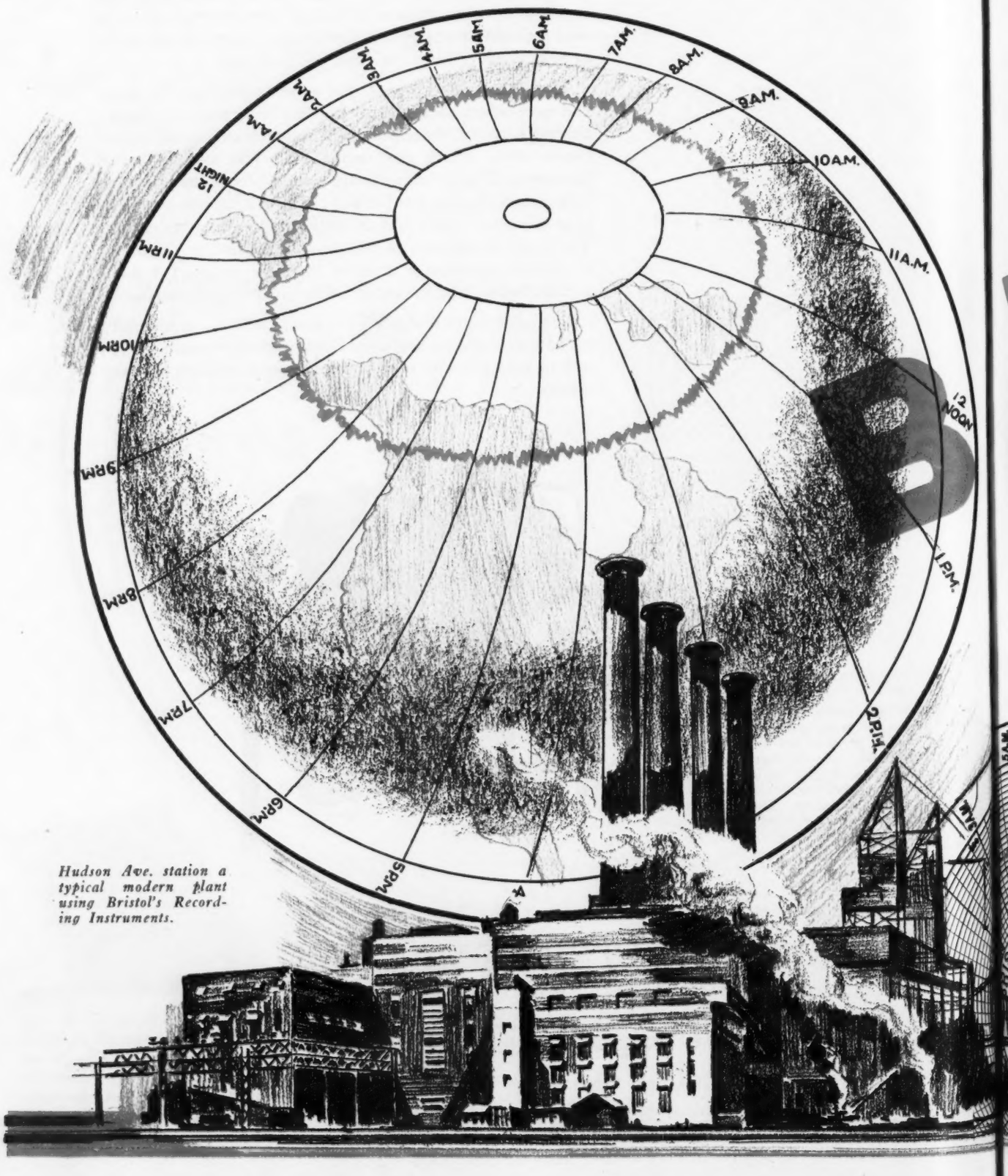
Represented in

ATLANTA
HOUSTON
KANSAS CITY
MEMPHIS
CHARLOTTE
NEW ORLEANS
DENVER
SAN FRANCISCO

A-334

This advertisement is one of a few suggestions so that you can BE SURE of the utmost economy in your power plant. The series is being reprinted in booklet form. On request, your name will be placed on the mailing list for a copy.

"Round the Worl



Hudson Ave. station a typical modern plant using Bristol's Recording Instruments.

d" high efficiency

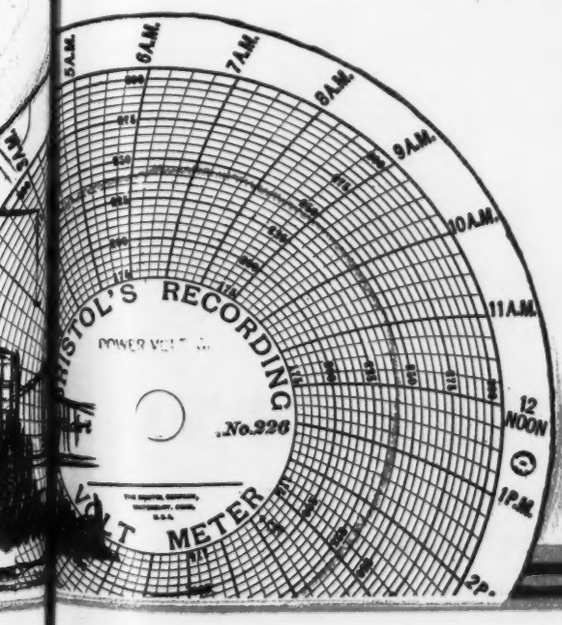
with

RISTOL'S

Hendrick Hudson proved that trade follows the flag. And at the Hudson Ave. station shown at the left whose location Hendrick Hudson must have passed on his memorable trip in the "Half-Moon," high efficiencies have followed Bristol's Recording Instrument installations. This is typical of Bristol's instruments in use the world over.

Wherever Bristol's Recording Instruments are installed, better efficiencies and higher economies are the rule. Bristol's simplicity of operation, high degree of accuracy, long life and other inherent advantages commend them to engineers in every nook and corner the world over.

With Bristol's, engineers are able to keep a close check on operating conditions and hence on efficiencies all along the line from turbine to feeders.



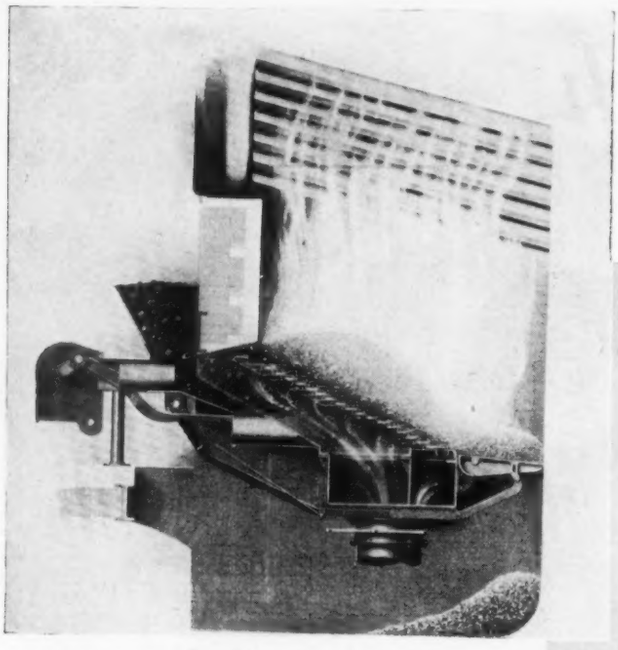
A complete set of Bristol's Bulletins contains much of interest for the solution of your everyday problems. Write for a set today.

The BRISTOL COMPANY
Waterbury, Conn.

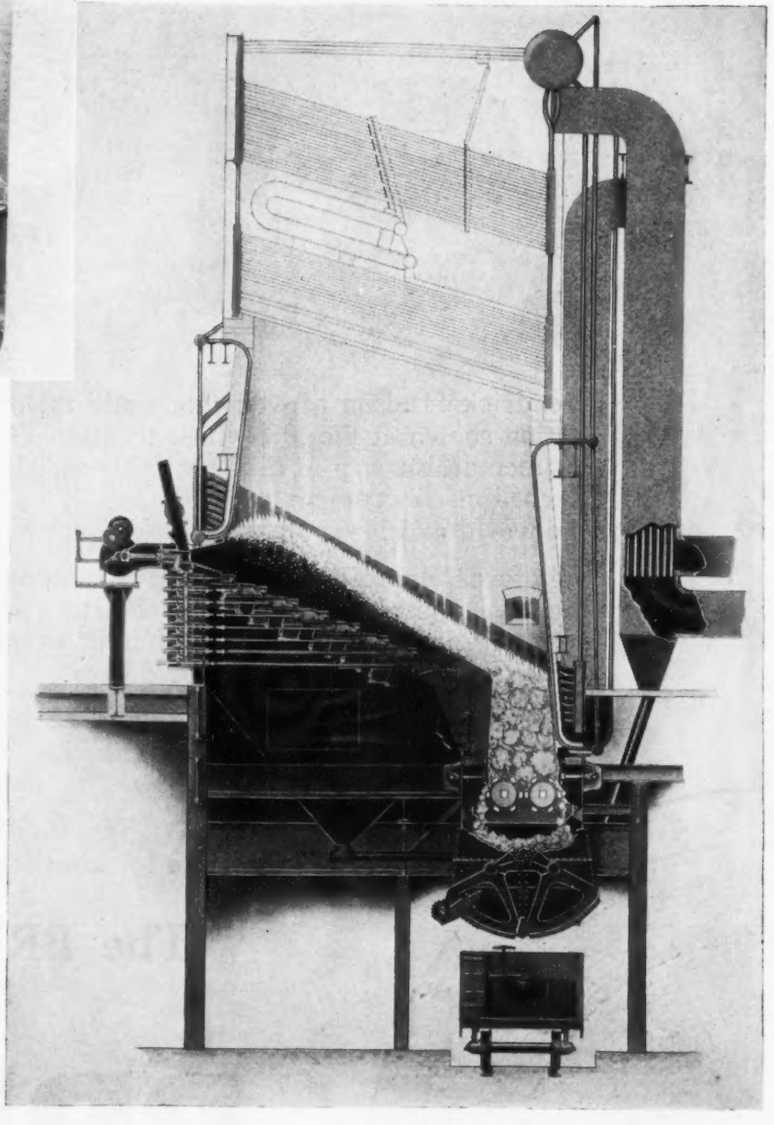
BRISTOL'S
Recording Instruments

TAYLOR STOKERS
JURUICK
REFRIGERATION

A-E-



Progress ▲▲



stoker of yesterday
. . . and of today

Above is a stoker of a type sold 20 years ago. At the right is a high-capacity Taylor Stoker built for the Delray No. 3 plant of the Detroit Edison Company.

Both are stokers, but how different . . . How they differ in fuel-burning economy, as well as size . . . These stokers visualize the advance in the art of burning coal and give a hint of the savings made possible by modern equipment . . . Your stokers may not be 20 years old; few need stokers as large as the one shown at the right, but between these two extremes there lies a vast field for saving money . . . for obtaining greater capacity from old boilers and burning coal more economically.

AIR COAL Taylor Unit For lower power costs

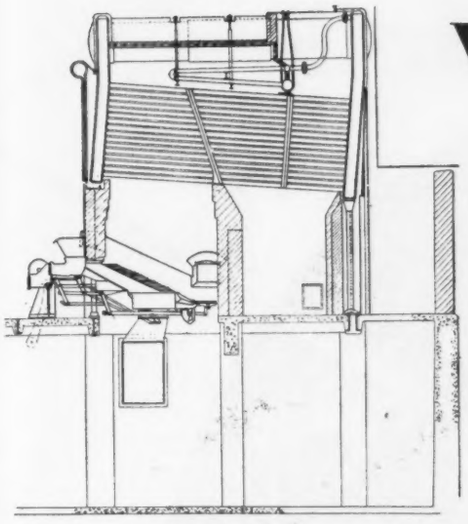
AMERICAN ENGINEERING

In Canada: Affiliated Engineering Companies, Ltd.
Head Office: Southam Bldg., Montreal, Que.

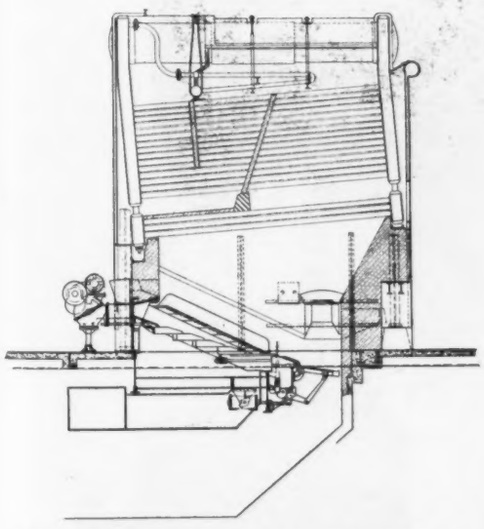
CO

LO-HED HOISTS
MARINE
AUXILIARIES

Boiler capacity doubled with new stokers



Twelve-year old underfeed stoker and boiler setting which was remodeled.



Remodeled boiler setting and modern Taylor Stoker installed under greater portion of boilers.

...FOR TWELVE YEARS, two 625 H. P. boilers had been fired satisfactorily by underfeed stokers. More steam was needed and the installation of a third boiler was being considered.

Then the suggestion was made that the additional capacity could be obtained more economically by revamping the old boilers and installing modern stokers.

The two cuts on this page show the changes that were made. It will be noted that the boilers were raised and turned around so that the tubes sloped toward the front of the stoker, thus increasing the furnace volume. An additional 1000 sq. ft. of tubes was added to each boiler, making the boilers 19 tubes high and 20 tubes wide, where before they had been 16 tubes high and 20 tubes wide.

The new Taylor Stokers were much longer than the old stokers and the entire length of the lower boiler tubes was exposed to the fire.

Formerly, the boilers ordinarily developed about 800 H. P., with peaks up to 1100. With the new settings, loads of 1250 H. P. are normal and peaks up to 1900 H. P. are handled successfully, although a lower grade of coal is burned.

The cost of a new boiler was avoided; the wages of one fireman on each shift were saved and the efficiency increased so that 13.2% less coal is required per pound of steam.

This is merely one illustration of the savings that can be made by installing modern stokers in place of older stokers. Our engineers will be glad to advise you regarding economies or increased output in your own plant.

COMPANY—PHILADELPHIA

In Great Britain: Taylor Stoker Company,
Bush House: Aldwych, W.C. 2, London, Eng.

A TRIBUTE

New York Steam Obtains Grand Central Contract

To Supply Group of Buildings; Road Abandons Own Plants

Arrangements to supply the entire steam requirements of 1,500,000,000 pounds annually to the Grand Central group of buildings have been completed by the New York Steam Corporation. The buildings included in the group extend from Forty-second to Fiftieth Streets and from Madison to Lexington Avenues, according to the statement issued by the corporation yesterday.

With the addition of the Grand Central group, the New York Steam Corporation will supply practically every important building in the midtown section.

The buildings included in the Grand Central group either are owned by the New York Central Railroad Company or have been erected by others on property leased from the railroad company for a long term of years. For some years the major steam requirements of the buildings have been supplied from two large steam generating stations owned and operated by the railroad company and located at Park Avenue and Fiftieth Street and at Lexington Avenue and Forty-third Street. Steam has been distributed through a system of pipe lines occupying land privately owned by the railroad company. The railroad company has been maintaining a break-down service contract with the New York Steam Corporation to insure continuity of service.

After a thorough study of the reliability of the steam corporation's service and an analysis of costs, the railroad company has decided to abandon its two stations and, together with the New York, New Haven & Hartford Railroad, has entered into a contract with the New York Steam Corporation.

View of Grand Central Zone, New York, containing the Grand Central Group of buildings whose steam requirements will amount to 1,500,000,000 pounds annually.

N. Y. Steam Corporation — Kip's Bay Station

COMBUSTION

TO RELIABILITY

"a thorough study of the reliability of the steam corporation's service"

The decision of the New York Central to abandon existing power plants and contract with the New York Steam Corporation for service, is a great tribute to the reliability of the service furnished by this company.

Combustion Engineering Corporation, has for many years, supplied fuel burning and steam generating equipment to the New York Steam Corporation.

In the Kip's Bay Station, their nearest plant to the Grand Central Group of buildings, are installed—C-E Boilers—Ladd Type, Lopulco Pulverized Fuel Systems, C-E Fin Furnaces, C-E Air Preheaters and Raymond Pulverizers.

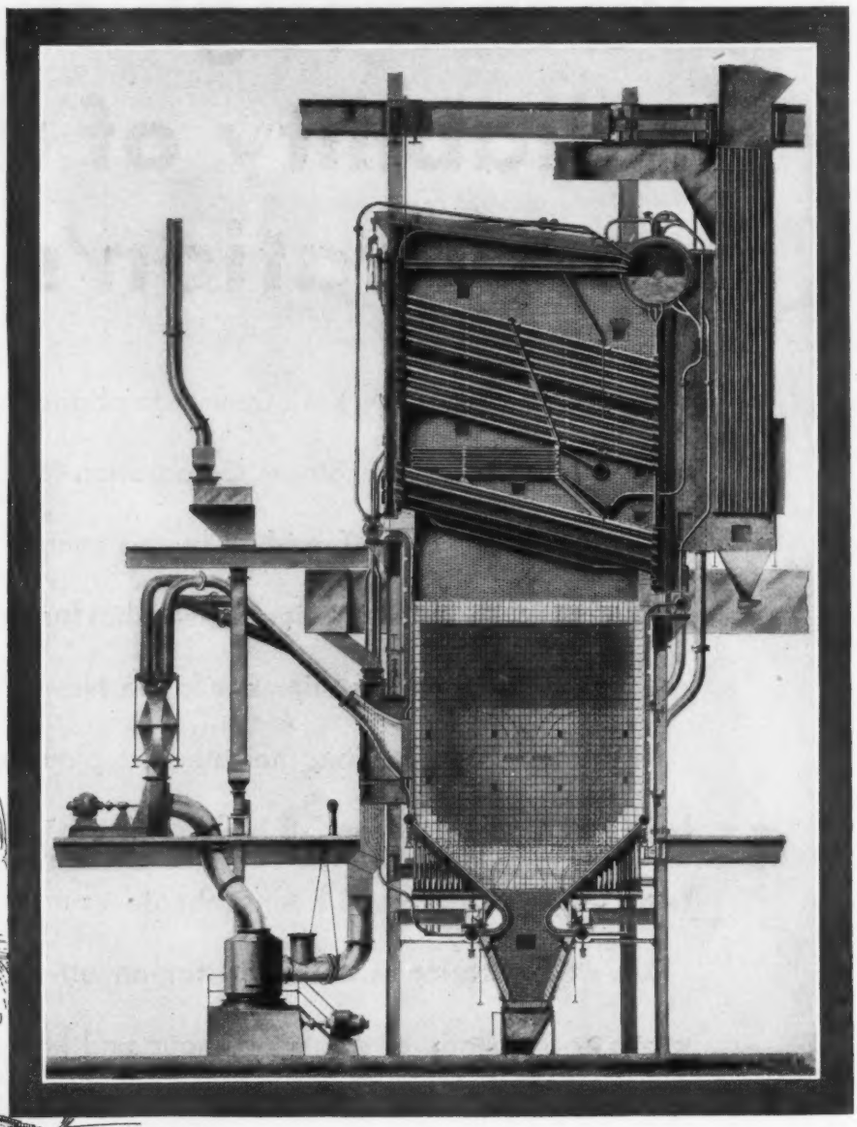
Kip's Bay Station is designed for an ultimate capacity of approximately 5,000,000 pounds of steam per hour and has already established records for steam production per unit and steam production per square foot of floor area.

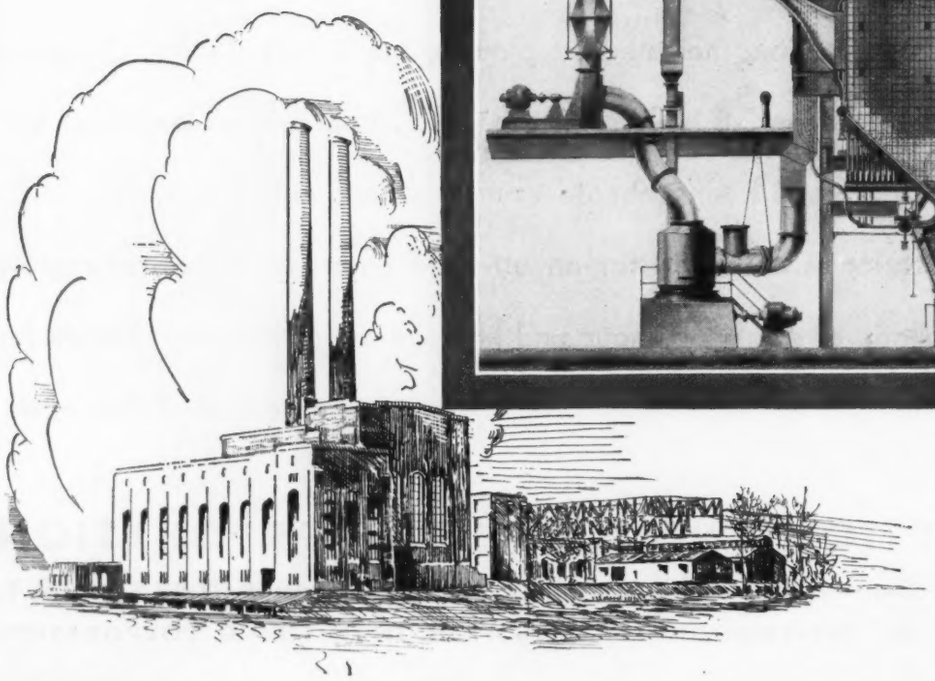
COMBUSTION ENGINEERING CORPORATION
International Combustion Building · 200 Madison Avenue, New York, N. Y.
A SUBSIDIARY OF INTERNATIONAL COMBUSTION ENGINEERING CORPORATION

ENGINEERING

PULVERIZED—

Typical Fuller Lehigh Direct-Fired Pulverized-Coal Installation with Bailey Water-Cooled Furnace of the Hopper-Bottom Type. This particular boiler has a maximum steaming capacity of 450,000 lbs. of steam per hour.





FULLER

COAL FIRING

Fuller Lehigh Direct-Fired System:—

An Important Factor in the Development of Large-Capacity Boiler Units of Increased Availability and Efficiency

The constantly increasing size of turbines used in modern central stations has brought about a demand for boiler units of increased capacity, availability and efficiency in order that electrical energy may be generated in large quantities at the lowest over-all cost.

The Fuller Lehigh Company's Direct-Fired System including mills, burners and furnaces, is a simple, clean and easily controlled system that has been an important factor in the economic development of large steam-generating units.

It is meeting these and other requirements in large modern central stations and is being generally adopted by central-station engineers and executives.

Reprints of trade-journal articles, technical papers, etc., giving actual performance data and showing equipment arrangements and photographs will gladly be sent upon request.

FULLER LEHIGH COMPANY, FULLERTON, PENNA.
A BABCOCK & WILCOX ORGANIZATION

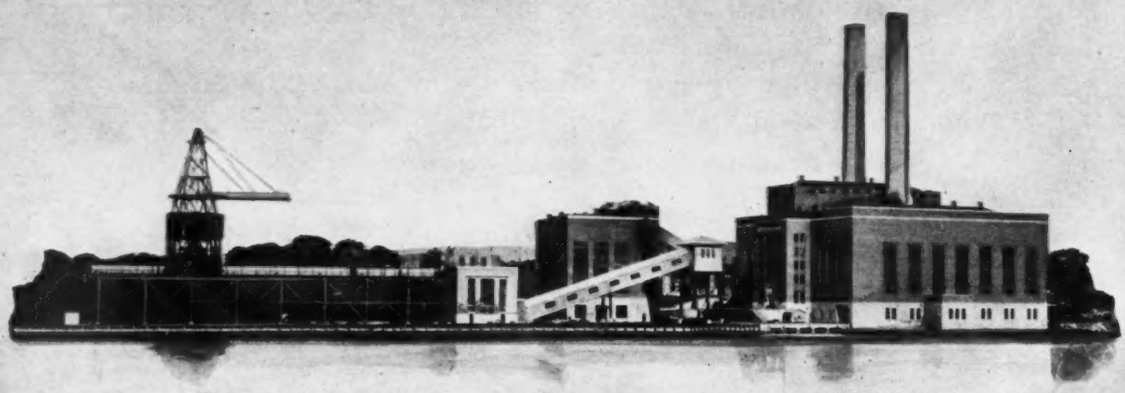
1—150T

LEHIGH

PULVERIZED COAL EQUIPMENT
WATER-COOLED FURNACE WALLS

SOLVING FUEL PROBLEMS

STEAM power station work of the Stone & Webster Engineering Corporation includes industrial and utility plants operating with record economy on all kinds of fuels. In many instances, coal, oil and gas burning stations are so designed that they can be changed at any time to pulverized coal. Some stations operate on either oil or pulverized coal or both as occasion demands. Some burn oil or gas or both. This flexiblity of design enables owners to profit by changes in the local fuel market. Our wide experience in solving fuel problems is offered to manufacturers and others who plan to build new plants or revamp old ones to meet new requirements.



STONE & WEBSTER
ENGINEERING CORPORATION

F B&D
ESTABLISHED 1894

Design--Construction Management of Public Utility and Industrial Properties

Since 1894, we have been engaged in the development of steam and hydro-electric power and electric railway plants, gas works, substations, electrical transmission lines and natural gas transportation and distribution systems.

To no lesser degree, our work has covered broadly the industrial field, including the development of more economical manufacturing methods and the building up of plant organizations.

In the transportation field our experience has made the rehabilitation of electric railways possible by the establishment of paying bus feeder lines and our studies have covered the economics of taxi, bus and airplane operation.

Appraisals

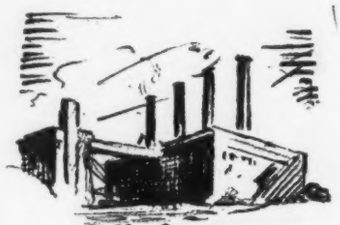
With a background of long engineering, management and financial experience we are particularly fitted to analyze and impartially evaluate all elements connected with any property or project and to submit authentic reports to owners, investors and bankers.

Ford, Bacon & Davis
Incorporated
Engineers

39 BROADWAY, NEW YORK

PHILADELPHIA CHICAGO SAN FRANCISCO
NEW ORLEANS CHATTANOOGA BIRMINGHAM

Sherman Creek


Hell Gate

East River

Steam Power Plants

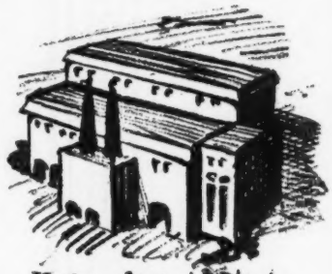
Greater Economy through Design

Thomas E. Murray, Inc., is credited with having designed steam power plants totaling greater capacity than any other in the country. Above are shown three of the great plants, serving New York City, all of which were designed by Thomas E. Murray, Inc. Each new plant has set higher standards with the result that through continuously improved designs, greater economies have been effected.

Our organization consisting of engineers, architects, and staffs, specializing in the various phases of their professions is backed by a record of 3,400,000 hp. in plants designed and on which construction was supervised.

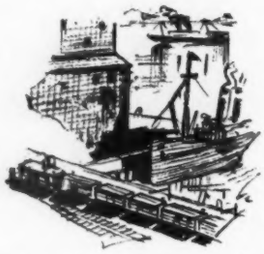
We would be pleased to discuss the design or redesign of plants.

Substations


Hydro-electric Plants

Office Buildings

Apartment Houses

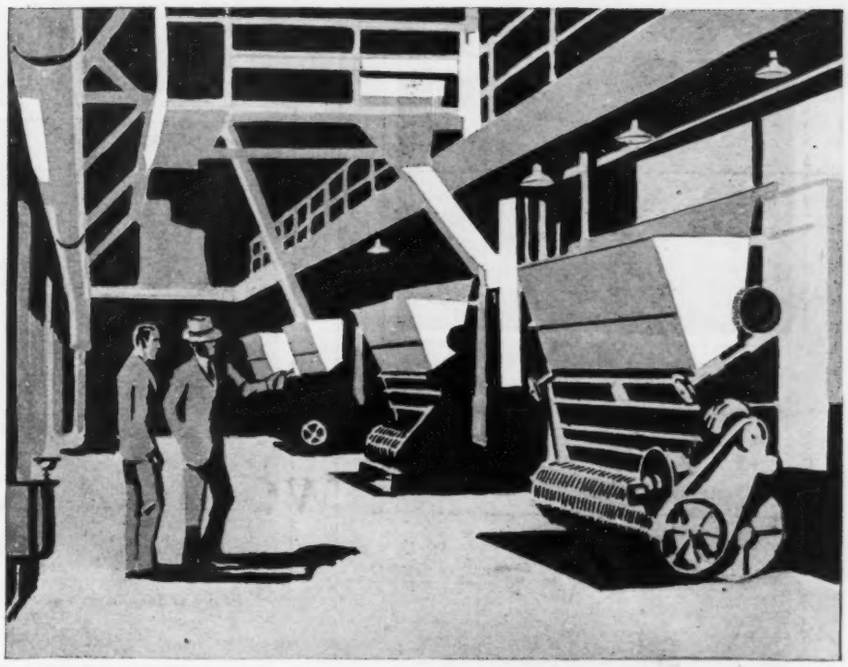

Power for Transportation

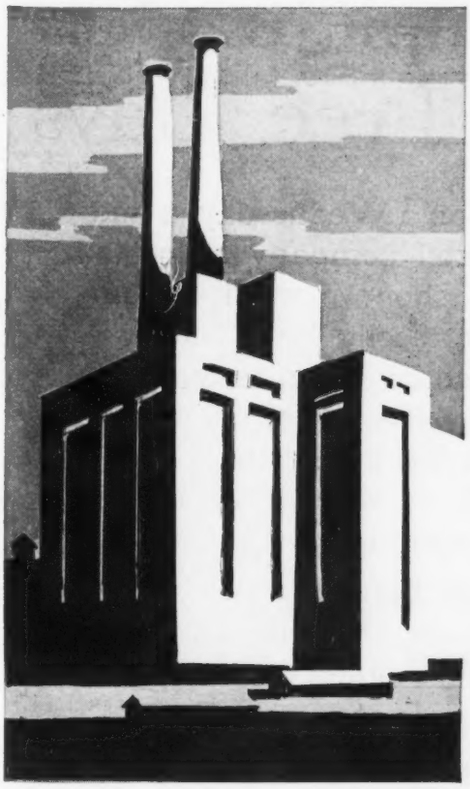
Industrial Plants

THOMAS E. MURRAY INC.

88 LEXINGTON AVENUE, NEW YORK, N. Y.
DESIGNING AND CONSULTING ENGINEERS
POWER PLANTS - INDUSTRIAL ENGINEERING - REPORTS - APPRAISALS
ARCHITECTURAL SERVICES

Increasing Investment Costs Demand the Surest Possible Protection





Public Utility Executives are keenly conscious of the rapidly narrowing margin of profit on investments that are already huge and must be constantly increased.

Every possible precaution must be taken against unnecessary loss—against the possibility of disaster in the great power plants upon which so much depends.

Ocean and Columbia Power Plant Policies give such protection—in two ways.

First: by a highly efficient inspection system which has proved its superiority in anticipating and detecting conditions which may *cause* losses.

Second: by prompt and equitable payment of any losses which *do* occur. All such losses are investigated and settled by engineers.

When your power plant is protected by an Ocean or Columbia policy you have transferred the burden of preventing or paying for losses to one of the strongest financial organizations in the world.

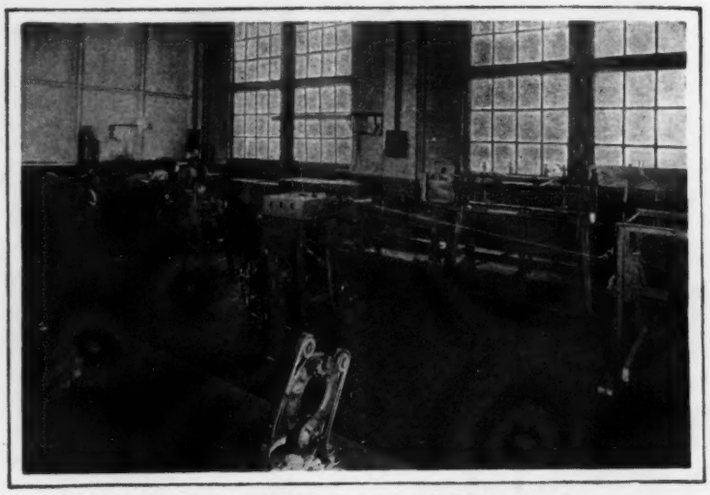
Correspondence is invited.

THE OCEAN ACCIDENT & GUARANTEE CORPORATION Ltd.
and
COLUMBIA CASUALTY COMPANY
1 Park Avenue, New York

Canadian Branch: Federal Building, Toronto, Ontario *Pacific Coast Branch:* 315 Montgomery St., San Francisco, Cal.

Section of testing room where all repair jobs are tested

Baking ovens in G-E service shop



Part of completely equipped winding room in G-E service shop

A Complete Job in Three Days

AT 5:30 p. m. on a Wednesday, a mid-western alkali company requested a G-E service shop to wind a complete set of stator coils for a 700-kv-a. synchronous motor. A message telephoned to General Electric's Fort Wayne Works brought 500 pounds of specially rolled and insulated wire to the service shop the next morning.

At 4:30 p. m. on Saturday, the service shop delivered to the customer the complete set of 96 stator coils for the machine.

The complete job done in three days—an accomplishment that any G-E service shop can equal.

Behind every G-E service shop are the resources of General Electric—research, engineering, and manufacturing. Added to this is an unfailing source of renewal parts of original equipment quality. There is a G-E service shop in each of the following cities:

Atlanta	Lynn
Buffalo	Minneapolis
Chicago	New York
Cincinnati	Seattle
Cleveland	Oakland
Dallas	Philadelphia
Detroit	Pittsfield
Erie	Pittsburgh
Fort Wayne	St. Louis
Kansas City	Salt Lake City
Los Angeles	Schenectady

91-30

JOIN US IN THE GENERAL ELECTRIC HOUR, BROADCAST EVERY SATURDAY AT 8 P.M., E.S.T. ON A NATION-WIDE N.B.C. NETWORK

GENERAL ELECTRIC

GENERAL ELECTRIC COMPANY, SCHENECTADY, N. Y., SALES OFFICES IN PRINCIPAL CITIES

FLOODLIGHTING CHURCHES

Night view of the Calvary Baptist Church at Roanoke, Virginia, floodlighted by four Golden Glow lantern floodlights, mounted on two standards installed at the curb-line.

Type L 1419-P Golden Glow Lantern Floodlight showing method of mounting reflector and lamp within the lantern. The glass panels have been removed in the illustration.

THE modern church can use floodlighting effectively. In both town and city, the shut-down of activities on Sunday evenings leaves many communities in comparative darkness. It is most desirable and most advantageous from the viewpoint of the church to focus the attention of the public on the churches, by means of floodlighting. There are other advantages of church floodlighting. It is not only dignified advertising, but provides illumination often necessary in stormy weather, and enlivens the spirit of the congregation. They are also used effectively to illuminate windows from the outside making them visible to the congregation.

Either Golden Glow lantern floodlights, or floodlight projector units may be used, but in most cases the lantern floodlight is most applicable, because of its ornamental advantages, easy installation at the curb-line, easy maintenance and control.

Our Bulletins Nos. 273 and 274 will be of great value to all interested, including Illuminating Engineers and Architects. Both the idea and the equipment are easy to sell, and provide a profitable load for the Utility at the off peak.

Typical standard and single lantern - flood light unit.

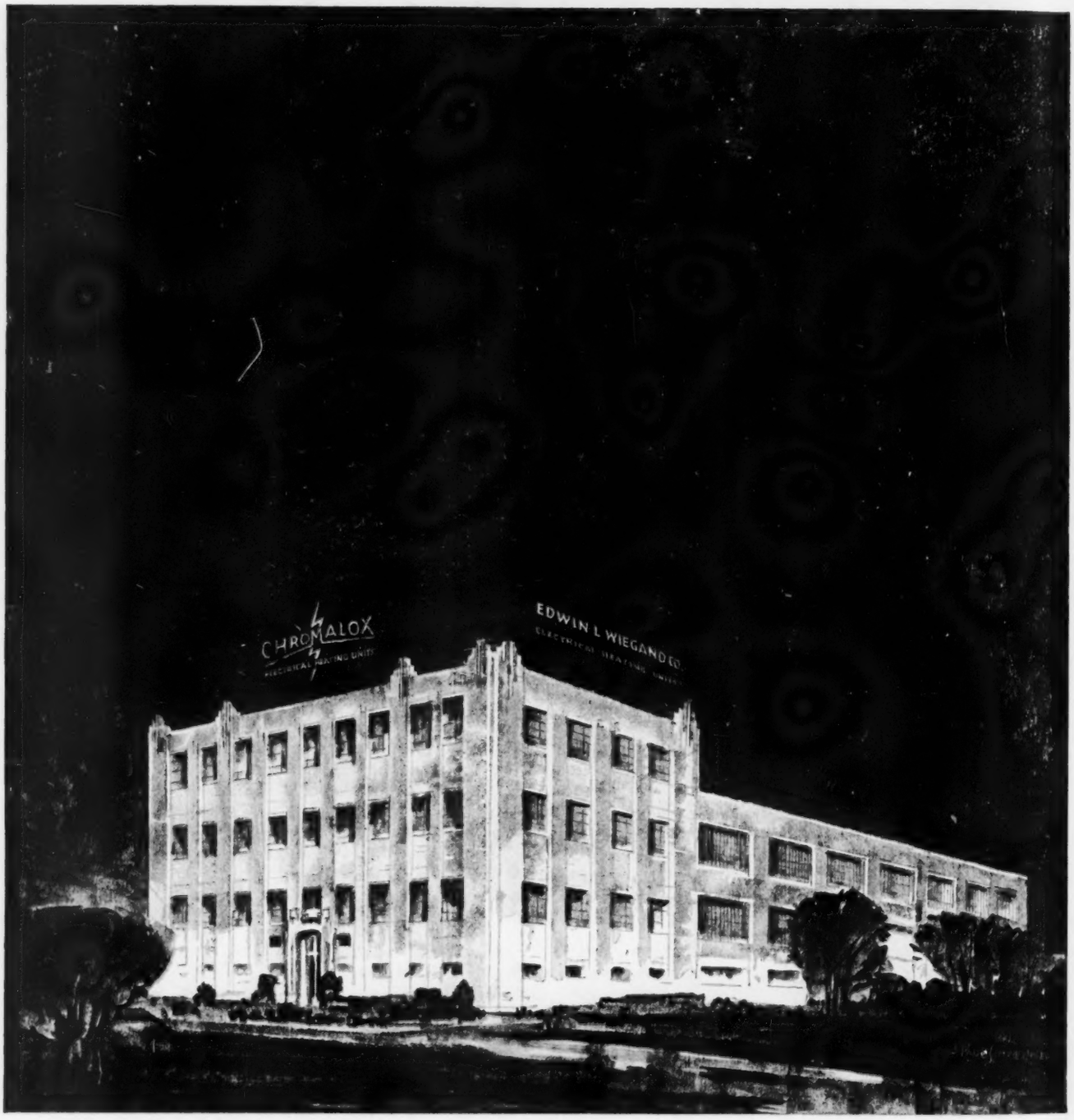
ELECTRIC SERVICE SUPPLIES CO.

MANUFACTURER OF RAILWAY, POWER AND INDUSTRIAL ELECTRICAL MATERIAL

Home office and manufacturing plant located at 17th and Cambria Streets, Philadelphia, Pa.; District offices are located at 111 North Canal Street, Chicago, Ill. and 50 Church Street, New York City.

Branches—Bessemer Bldg., Pittsburgh, 88 Broad Street, Boston; General Motors Bldg., Detroit; 316 N. Washington Ave., Scranton; Canadian Agents—Lyman Tube & Supply Company, Ltd., Montreal, Toronto, Vancouver.

. . . . *further proof*



RAILWAY OFFICIALS

will be interested in seeing Railway Utility Co's exhibit of high duty railway heaters

BOOTH 550-B

American Electric Railway Association Convention, Atlantic City, Sept. 28th to Oct. 4th

RAILWAY UTILITY CO.

of Chicago, Sole Distributor of Chromalox strip heaters for railway and street cars in the United States and Canada

THIS new factory is entirely devoted to the development, engineering and manufacture of Chromalox heating units, and their proper application to commercial and industrial heating problems. This partial list of appliances and heating devices convincingly shows the trend of leading manufacturers towards adopting Chromalox embedded type units. Today, more than 100 electrical manufacturers are making their products trouble-free by standardizing on patented Chromalox units.

Air Heaters, for residences
Air Heaters, industrial
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Beauty Parlor Appliances
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Waffle Irons
Waffle Bakers
Water Heaters, Domestic
Water Heaters, Poultry

that the industry is turning to the ★embedded type *heating unit*

as best represented in the Chromalox line of heating units

More and more the appliance industry is definitely turning to the embedded type Chromalox element for the solution of its heating problems.

The reason is obvious. The superior Chromalox construction makes it possible for these patented units to stand up under very severe usage. They have more inherent strength both structurally and electrically.

If you are in any way interested in the heating appliance field, here, point by point, are the exclusive Chromalox advantages which you should know about.

1. BUILT TO WITHSTAND OVERVOLTAGE and resulting overwattage, Chromalox units invariably eliminate usual trouble caused by voltage fluctuations.

2. HIGHLY EFFICIENT HEAT DISSIPATION due to refractory being compacted so hard under hydraulic pressure and baked at red heat. Heat transfer comparable to that of iron.

3. UNEFFECTED BY SEVERE ABUSE AND VIBRATION as proven by outstanding success in railway car heating. Over 150,000 Chromalox strip heaters now heating cars on 120 railways—the toughest kind of work!

4. MAXIMUM DEGREE OF UNIFORMITY IN MANUFACTURE. Chromalox units, manufactured on a standardized production basis, are made possible only through the Chromalox process and the use of Chromalox equipment.

5. HIGH INSULATING VALUE OF REFRACTORY —improves with age and use, whereas other forms depreciate.

6. BAKED AT RED HEAT after the resistor is embedded in it, Chromalox refractory will not absorb moisture.

7. HEAT DISTRIBUTION CAN BE VARIED to meet special requirements with maximum safety from local deterioration.

8. CHROMALOX ARE NOT THE CHEAPEST UNITS from cost per unit. But they are the cheapest unit from service-hour cost due to their unusually long operating performance.

★*having the resistor embedded in refractory material under hydraulic pressure and baked at red heat.*

★Chromalox
ELECTRIC HEATING UNITS

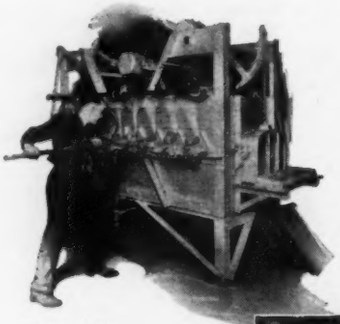
Manufactured Exclusively by Edwin L. Wiegand Company, 7500 Thomas Boulevard, Pittsburgh, Pa.

SOLE LICENSEES: Canadian Chromalox Co.,.Ltd., Toronto, Canada ABROAD: Geo. Bray Co., Leeds, England

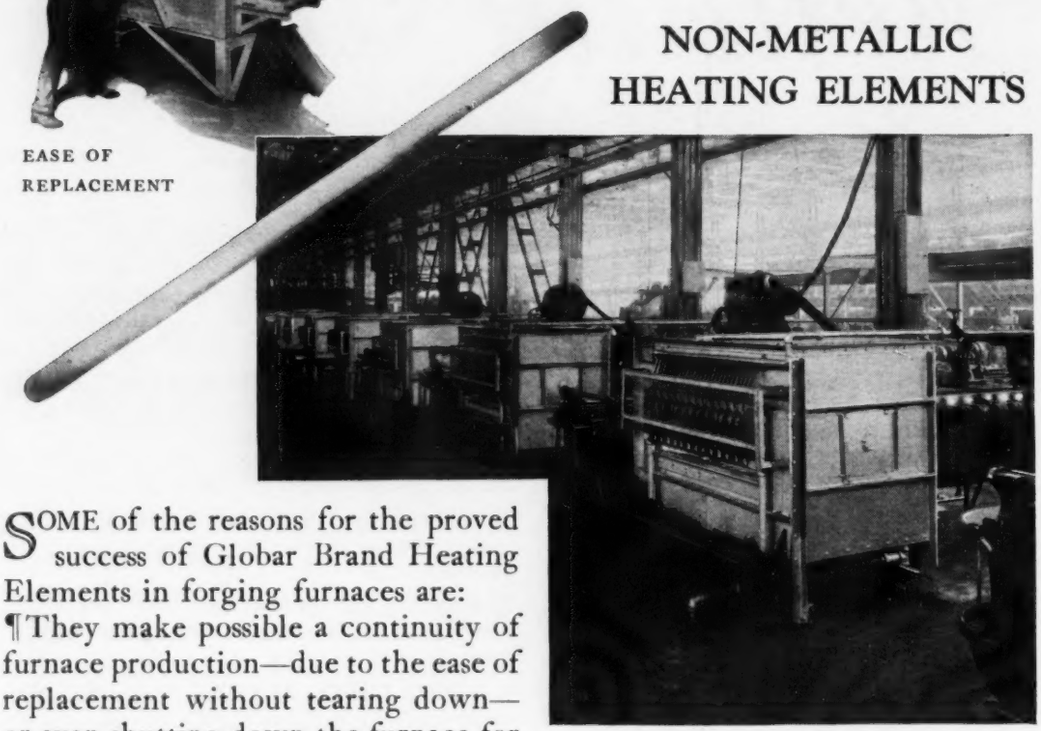
An outstanding success in
FORGING FURNACES—

Globar BRAND
REG. U.S. PAT. OFF.

NON-METALLIC
HEATING ELEMENTS



EASE OF
REPLACEMENT



SOME of the reasons for the proved success of Globar Brand Heating Elements in forging furnaces are:

¶They make possible a continuity of furnace production—due to the ease of replacement without tearing down—or even shutting down the furnace for installing new elements.

¶They make possible close temperature control—the elimination of "burned steel."

¶With Globar Brand Elements furnace design is simplified—minimum dimensions per furnace resulting in maximum production per unit of floor space.

FURNACES BUILT BY
HOLCROFT & COMPANY, DETROIT, MICH.

Glad to place at your disposal the research resources of our Engineering Department

Globar is the registered trade name given to non-metallic electrical heating and resistance materials, and to other products of Globar Corporation, and is its exclusive property.

GLOBAR CORPORATION
NIAGARA FALLS, N. Y.

A LOOK INTO THE FUTURE

of Electric Water Heating

A complete line of Hotpoint high and low wattage electric water heaters to fit every rate structure and to solve every distribution problem. Also automatic peak limiter, Y 121, and automatic time switch, Y 200, are offered as important developments for water heating service.

COMPANIES engaged in water heating business or who contemplate going after this load must necessarily take a look into its future possibilities and problems. Planning this business only on the factors that loom up now may cause endless troubles in due time. This is why the 18 years of experience gained by Hotpoint in the development and sale of electric water heaters is so valuable to central stations. To us, this business is not new—with our customers we have weathered the storm of disturbance of rate structures, helped solve distribution problems and assisted in many other questions that have arisen during this period of time.

As a result of our experience we have developed a complete line of electric water heaters to meet any condition, rate structure or distribution problem and have data that is extremely helpful to central stations.

Our water heating specialists are at your service to assist you in solving your water heating problems.

Let them help you take a look into the future of electric water heating. Mail the coupon today for full details of our water heating plan that meets the needs of every central station.

Three Hotpoint Water Heater Developments

1. Patented Hotpoint Calrod heating element more efficient, economical and practically indestructible. Element is always clean because of self-rescaling action.
2. Patented Double-Wall Circulation Tube delivers hot water to the top of the tank where it is quickly available.
3. Positive automatic heat control, accurate, simple and durable—many in use for years prove their long life.

Hotpoint

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Every all-electric radio on your line adds a total of $10 a year to your revenue

THE annual revenue to Central Stations for the current consumed in the average operation of a single all-electric radio totals $10. This revenue comes from the direct load which radio puts on the Central Station lines and from the secondary load —the added *lighting load*—directly due to use of radio.

Since all-electric radio was first introduced, more than 3,000,000 sets have been put in operation. And yet the market has barely been scratched. Only 14 out of every 100 wired homes have electric radios.

Here is a wide-open field for Central Stations. Electric radio is accepted. It is a product that lends itself to volume sales and profits. It is a load-builder and a builder of good will.

With Atwater Kent Radio you can develop the market quickly. Atwater Kent Radio is nationally known, nationally advertised—in demand everywhere. It comes from the largest radio factory—built on the good will of 2,550,000 families who have bought Atwater Kent Radio over a period of seven years. It is famous as the radio of low servicing requirements. It keeps on working—and you keep on furnishing the current.

Meet the demand of your customers for all-electric radio with the Atwater Kent Screen-Grid Radio . . . the greatest advance in radio since the advent of the house-current set. It is a perfected, all-electric radio. It satisfies completely . . . in range, needle-point selectivity, distance-getting ability, Electro-Dynamic tone! For more information write direct to our Utility Sales Division.

IN CABINETS—The best of American cabinet makers —famous for sound design and sincere workmanship— are cooperating to meet the demand for Atwater Kent Screen-Grid Radio in fine cabinets like these.

Prices slightly higher west of the Rockies, and in Canada

TABLE MODEL—Screen-Grid Receiver, Model 55, without tubes, $88. Model F-4 Electro-Dynamic tablespeaker, $34.

ATWATER KENT MANUFACTURING COMPANY *A. Atwater Kent, President* 4712 Wissahickon Avenue, Philadelphia, Pa.

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Sell entertainment to your customers

ANOTHER of the many beautiful cabinets made expressly for Atwater Kent Screen Grid Radio by masters of furniture craftsmanship. Simple or elaborate designs.

When you sell Atwater Kent Screen-Grid Radio you provide your customers with an accepted means of entertainment. You show them how to use the current for their pleasure as well as for their comfort and convenience . . . entertainment . . . as they like to have it!

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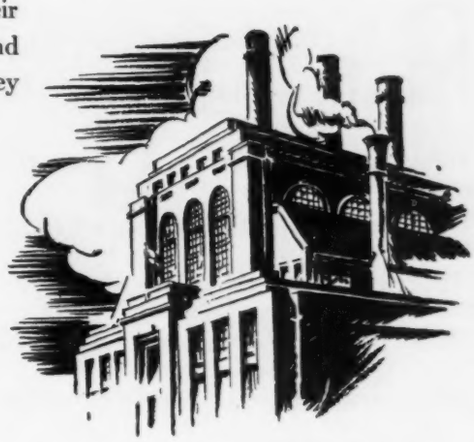
WEAF network of N. B. C.

Atwater Kent Mid-Week Program
Thursday Evenings, 10:00 (Eastern Daylight Time)
WJZ network of N. B. C.



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It's GraybaR all the way

Start at the "bus bar" in the power plant. End up at the light in the top floor window. And you've traced a line of typical Graybar equipment... ...all the way... every inch, every item! Graybar selects thousands of electrical items from the markets of America, so you may have what you want. Graybar warehouses them nearby, so you may have *what* you want *when* you want it. Make Graybar your supply room for all things electrical. Thousands of electrical buyers have proven the wisdom of this course.

THE GRAYBAR TAG —SYMBOL OF DISTRIBUTION

GRAYBAR ELECTRIC CO. Offices in 72 principal cities
Executive Offices: Graybar Bldg., Lexington Ave. and 43rd St., New York, N.Y.

Lets get all THE FACTS on electric heat

When they say: *How can electric heat help Aviation?*

the answer is:

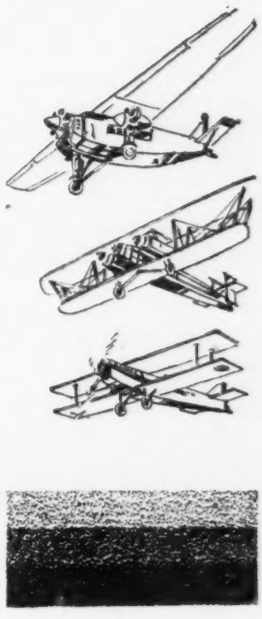
Heater for Warming Airplane Engine Oil

A new electric heating unit designed especially for warming the engine oil of aircraft to facilitate quick starting, especially in cold weather, is announced by the General Electric Company. The unit will operate from the local electric lighting circuit in the hangar.

When planes are stored in unheated hangars it has been customary during cold spells to drain the lubricating oil from the oil tank after flying operations in the evening and to preheat the oil in the morning.

The new electric heating unit consists of two 110-volt, 375-watt heating units conveniently shaped to fit into the conventional aircraft oil tank by insertion through the filter cap. Three degrees of heat are provided. The units can be operated in series for low heat intensity, they can be used as a single unit for intermediate intensity and they can be operated in parallel for high intensity. The corresponding wattage values are 187, 375 and 750 respectively at 110 volts.

—Electrical World, July 13, 1929.



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HARRISON, NEW JERSEY
Chicago-Detroit-Morristown, N. J. England-France
In Canada The B. Greening Wire Co., Ltd., Hamilton

Nichrome IV
High Temperature Service
the ideal heating element resistance wire

THROUGH a generation of research and development this company has built solidly until today it operates the largest plant in the world devoted to alloy products . . . .

. . . . melting furnace, rolling mills, technical control over every step in fabrication—plus the priceless ingredient EXPERIENCE assure not only quality but UNIFORMITY of quality, impossible to obtain by lesser qualifications.

How the Modern Plant Moves Material Faster at Less Cost

Electric industrial trucks and tractors release man-power for more productive work

STUDY your material-handling costs. By doing this, hundreds of modern plants have found numerous ways to greatly reduce their overhead.

Consider these questions

What does it cost you to unload material and place it in storage? What does it cost you to move this material and place it in operation? What does it cost you to move manufactured goods in process? What does it cost to store finished products and move them from storage to the shipping platform? How many men are you using for this work? Couldn't they be released from burden-bearing to more productive work?

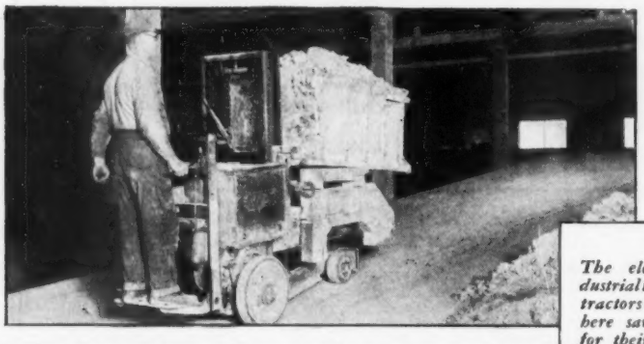
Why the answers mean money saved

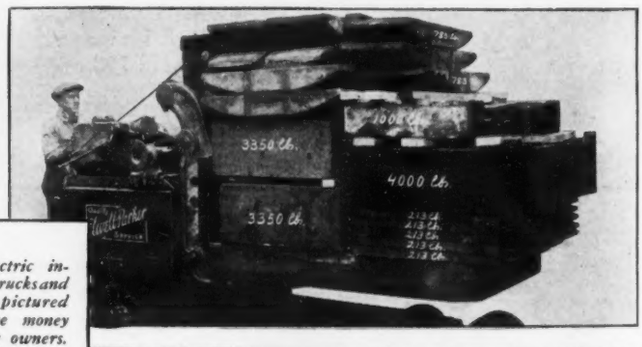
The answers to these questions may show you the way to save thousands of dollars in *your* plant.

For in every instance electric industrial trucks and tractors may readily move more material faster at less cost. Since they do it for others, they can do it for you.

Actual results

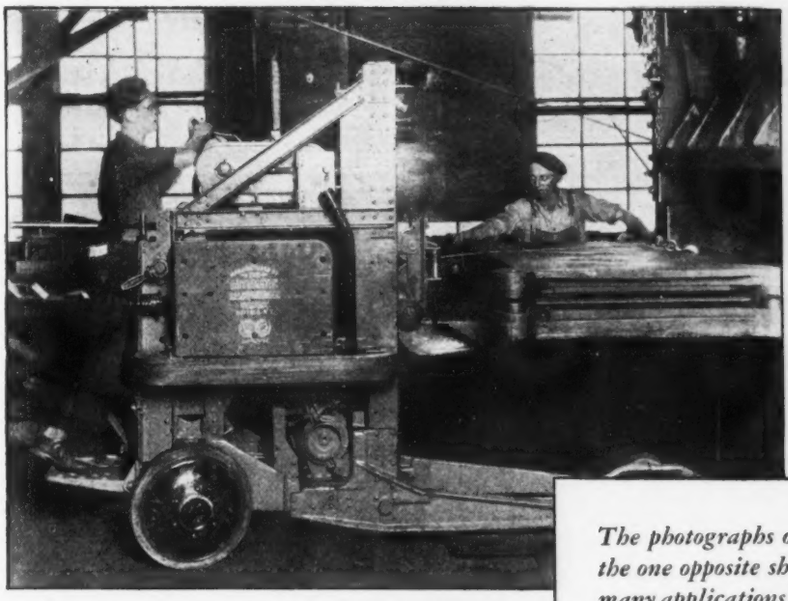
A great Eastern railroad system reduced the cost of handling at two of its terminals from $0.88 to $0.32 per ton by the use of skids



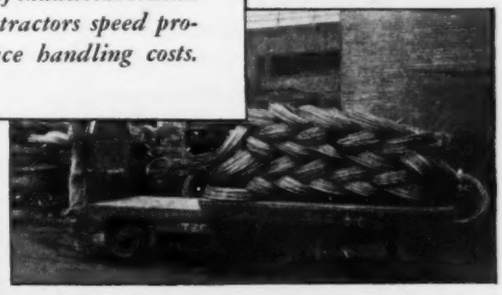


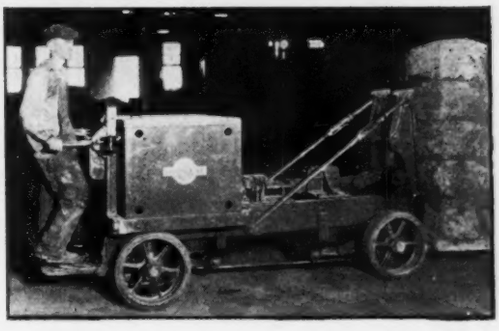
The electric industrial trucks and tractors pictured here save money for their owners. Day-by-day, they move more material faster at less cost.

USE ELECTRIC INDUSTRIAL TRUCKS AND TRACTORS



The photographs on this page and on the one opposite show a number of the many applications of industrial trucks. These trucks and tractors speed production . . . reduce handling costs.





and electric trucks. Think what a better than 60% reduction in your material-handling costs would mean to you in actual dollars saved.

To suit any job

Pictured on these pages are a number of industrial trucks and tractors that show conclusively their wide adaptability. They're on the job, today, powered with Exide-Ironclad Batteries, like thousands of others.

Exide-Ironclad Batteries maintain a consistently high voltage that results in good speed all day long. They have a tremendous power to give current steadily or in a rush for extra-heavy loads. They are economical at the charging panel, and their unique positive plate construction insures unusually long life.

Exide
IRONCLAD
BATTERIES

Write for bulletin

Bulletin 160-R will be sent to you on request. It gives information about the many uses of electric industrial trucks and tractors. Write for a copy today.

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The varied experience of a consulting engineer coupled with your particular knowledge of your business, makes for a quicker and more effective solution of your operating problems.

Many times a simple suggestion by a competent consulting engineer effects such greater economies that the cost of his services is returned a hundred times over.

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Proposals, 40 cents a line an insertion.

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Box Numbers in care of any of our offices count 10 words additional in undisplayed ads.

Discount of 10% if one payment is made in advance for four consecutive insertions of undisplayed ads (not including proposals).

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1 to 3 inches.....$6.00 an inch
4 to 7 inches.....5.75 an inch
8 to 14 inches.....5.50 an inch

An advertising inch is measured vertically on one column, 3 columns—30 inches—to a page.

E.W.

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COMPETENT, high-grade, steam engineer who thoroughly understands electric central station operation. Location Arizona. P-301, Electrical World, 883 Mission St., San Francisco, California.

LOAD dispatcher by large New York State utility. Stage age, education, experience, and salary desired. P-300, Electrical World, Tenth Ave. at 36th Street, New York.

WANTED, an electrical draftsman with some experience on substation and power house layout. In answering give full information as to age, education, experience, when available, etc. Excellent opportunity with fast growing company. P-288, Electrical World, Tenth Ave. at 36th Street, New York.

Distribution Superintendent

Suburban town—10,000 customers—in Massachusetts. Requirements—graduate of recognized tech. school, about 35 years old, good moral character, experience in distribution work and supervision of maintenance and construction crews. A good opportunity for well qualified, energetic man. Reply with complete details of education, personality, training, salary required, etc. An interview will be arranged for selected applicants.

P-231, Electrical World
Tenth Ave. at 36th St., New York City

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WANTED—Experienced electrical draftsmen and designers by manufacturer of high grade control apparatus in Middle West. State experience and salary expected. P-296, Electrical World, 520 N. Michigan Ave., Chicago, Ill.

YOUNG graduate engineers for apparatus designed by large electrical manufacturing company: Eastern location. Some practical experience preferred, but not essential. Send small photograph if possible. Address replies with full details. P-274, Electrical World, Tenth Ave. at 36th Street, New York.

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COLLEGE graduate, age 30; 9 years' experience electrical, mechanical, drafting, design and commercial; testing of medium sizes industrial motors and apparatus. PW-303, Electrical World, 520 No. Michigan Ave., Chicago, Ill.

ELECTRICAL engineer or chief electrician with 13 years' practical experience, desires permanent connection with utility or industrial concern, technical graduate, age 30, seven years Westinghouse test and assembly, six years installation operation and maintenance motors and distribution system. Can take full charge of electrical equipment. PW-302, Electrical World, 520 No. Michigan Ave., Chicago, Ill.

ELECTRICAL engineer, young. Personnel training and appraisal experience. Knowledge accounting. Desires position involving combination of business and engineering ability in or near New York City. PW-304, Electrical World, Tenth Ave. at 36th St., New York.

GENERAL line foreman or foreman to maintain and construct. Having vast experience in general construction of high and low tension lines and maintenance of same. Expert on erection of cable. Reference. PW-298, Electrical World, Tenth Ave. at 36th Street, New York.

MECHANICAL and electrical engineer, heat-balance calculations, power plant transmission line and substation design heating and ventilating. Some chemical and refrigerating experience. Only responsible position considered. PW-294, Electrical World, Tenth Ave. at 36th St., New York.

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POSITION wanted as branch manager or sales engineer. Cincinnati territory, age 42, married, electrical and mechanical engineer; 12 years on this territory. Address Ralph E. Dodson, 307 Altamont Rd., Covington, Ky.

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1—300 kw. 230 v., 3 ph., 60 cy., 2300-4600 v. Synchronous Motor Generator set.

1—200 kw., 230 v., 3 ph., 60 cy., 2300-4600 v Synchronous Motor Generator set.

1—150 kw., 600 r.p.m., 250 v., Gen., 3 ph., 60 cy. 220-440 v., G.E. Synchronous motor.

1—125 kw., 250 v. Westinghouse Synchronous Gen. Motor Set, 3 ph. 60 cy. 230-2200 v.

1—100 kw., 125 v., D.C. 220-440 A.C. G.E. Synchronous Motor Generator Set, 220 440 v.

1—100 kw., 250 v., Gen., 900 r.p.m., 2200 Synchronous Motor.

1—85 kw., 250 v. 1200 r.p.m., 3 ph., 60 cy., 220-440 v., G.E. Synchronous Motor.

1—75 kw., 250 v. Generator, 3 ph., 60 cy., 2200 v., Synchronous Motor.

1—60 kw., 125 v., C.W., 3 ph., 60 cy., 220-440 v. Motor.

1—50 kw., 250 v., Westinghouse 3 ph., 60 cy., 220-440 v.

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1—2500 kva., 3600 r.p.m., 2300 volts, 3 phase, 60 cy., Westinghouse and Worthington Condenser 8 years old, good condition.

—937 kva., 750 kw. 8 P.F., 3 ph. 60 cy., 480 volts 3600 r.p.m. Gen. Elec. Non-Cond. with exciter (used one year).

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2—1500–3000 kva. G.E. combined oil and water cooled 3 ph., 60 cy., 11000-2200-2300 v.

A.C. GENERATORS

No.	Kw.	R.p.m.	Volts	Ph.	Type
1	400	360	480	3	G.E. "B"
2	300	1200	2300		Westg.
1	250	600	440	3	Westg.
2	125	900	2300	3	Cr.-Wh.
2	100	900	230–2300	3	G.E.
1	75	600	220	3	Westg.
1	75	900	2300	3	G.E.
1	50	1200	220–440	3	G.E.
1	50	1200	2300	3	G.E.

MOTORS—3 Phase, 60 Cycle

No.	Hp.	R.p.m.	Volts	Type
1	750	720	440-2200	G.E., slip ring
1	600	360	440	G.E. syn.
1	500	720	440-2200	G.E., slip ring
3	450	1200	2300–4150	Westg. syn
2	350	1200	2300–4150	Westg. syn
2	300	600	445–2300	G.E. syn.
1	250	600	220–440	Westg. syn.
1	250	600	440–2200	G.E. syn.
3	200	514	4150–2300	G.E. syn.
4	150	1200		Westg. sl. rg.
1	150	900	2300	G.E. syn.
2	150	514	2200	Westg. sl. rg.
1	150	1800	2200	Westg. sq. cg. mtr.
1	100	900	440–2200	G.E. sq. cg.
1	100	900	220–440–220	Westg. sq. cg.
1	75	600	220	G.E. sq. cg.
1	75	600	220	Fair.-M. sl. rg.
1	75	490	440	Allis-Chal. sl. rg.
1	75	900	2200	G.E. Kt.
1	60	1200	220	G.E. sl. rg.
1	60	720	220–440	G.E. Kt.
1	60	300	220–440–230	Fair.-M. syn.
1	50	600	2200	G.E. MT sl. rg.
1	50	900	2200	G. E. B.
1	50	1200	220–440	Wagner sl. rg.
1	40	1700	220–440	Westg. sl. rg.
1	40	1200	220–440	G.E. Kt.
1	25	900	440–2200	Cr.-Wheeler
1	25	1200	440	G. E. K.

(2 Phase Motors on Request)

BRAND NEW MOTORS

No.	Hp.	R.p.m.	Volts	Type
1	40	900	220–440	Gen. Electric KT
1	40	1200	220–440	Gen. Electric MT
1	30	1200	220–440	Gen. Electric KT
1	30	900	220–440	Gen. Electric KT
5	25	900	220–440	Gen. Electric KT
4	25	600	220–440	Gen. Electric KT
1	15	1200	220–440	Gen. Electric KT
2	15	1200	220–440	Gen. Electric MT
1	10	1200	220–440	Gen. Electric MT
5	7½	900	220–440	Gen. Electric MT

D.C. Generators

No.	Kw.	R.p.m.	Volts	Type
1	300	1200	250	Cr.-Wheeler
1	300	1200	125	Brand new G.E.
1	200	900	250	G.E.
1	200	600	250	G.E.
2	150	1200	250	Cr.-Wheeler
1	150	600	250	G.E.
2	150	1200	250	Westg., new
1	100	720	250	G.E.
1	75	450	250	Diehl
1	50	600	250	Westg.
1	30	1000	250	Westg.

(Smaller Sizes on Request)

D.C. MOTORS—230 VOLT

No.	Hp.	R.p.m.	Type
1	350	1100	Cr.-Wheeler
1	250	550	G.E.
2	200	1150	Cr.-Wheeler
1	150	600	G.E.
3	150	850	Westg. SK, new
1	150	1100	Westg. SK.
1	125	550	Cr.-Wheeler
1	100	625	Westg. Type S
1	80	500	Allis-Chal.
2	75	475	Westg. Type S
1	50	560	Westg. Sk.
1	50	650	Sprague
1	40	400	Diehl
1	40	1300	Diehl
1	35	200	Diehl
1	35	700	Cr.-Wheeler
1	35	420	Diehl
1	20	665	Diehl
1	20	200	Diehl
1	20	900	Diehl

(Smaller Sizes on Request)

D.C. MOTORS—125 VOLT

No.	Hp.	R.p.m.	Type
1	125	575	G.E.
1	100	600	G.E.
1	80	600	G.E.
3	25	1200	Sprague
1	20	650	G.E.
1	15	775	SK Westg.

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440 HP. Heine, 190 lbs. ASME Code. Hand Fired, 4 years' service. Still in brickwork. Price, F.O.B. Chicago..$3000.00

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25 Kw., G. E. 125 volt Generator; dir. con. 35 HP. G. E. 3—60—440/220 V. Motor $400.00

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312 Kva. Electric Machinery, 3—60—2300/440/220 V. Alternator; dir. con. by 21x22 Skinner Uniflow Engine. Seen operating $3,500.00

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1—500 kw. G.E., Curtis turbine, 150 lb. cond., 2300 v., 3 ph., 60 cy.

1—75 kva., 240 v., 3 ph., 60 cy., 1200 r.p.m., C-W alternator dir. con. to Sturtevant turbine, non-cond.

1—15 kva., 220 v., 3 ph., 60 cy., 1800 r.p.m., dir. con. to Sturtevant turbine, 80 lb. pressure.

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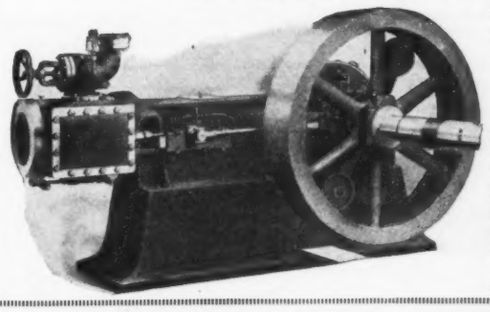

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2—150 hp., 720 r.p.m., G. E., Type I, Form K, 220/440 v. motors, with compensators, bases and chain drives, ratio 5 to 1.

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1—2500 kw., 3125 Kva. General Electric (Lynn rigid frame type) 150/200 lbs. steam, 3600 r.p.m., 3 phase, 60 cycle, 2300 vs. with Worthington Surface Condensing equipment.

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(Central Station Type)

1—1500 Kw., 1875 Kva. Westinghouse, 3 phase, 60 cycle, 2300 vs., 373 amps., 3600 r.p.m., 175/200 lbs. steam pressure with Alberger Jet Condensing equipment.

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1—150 Kva. Westinghouse, 3 phase, 60 cycle, 2300 vs. generator direct connected to 17x18 Ames right hand side crank Ames Unaflow Horiz. engine.

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Generator: 200 Kw. self contained Westinghouse 125 v., 1,600 amp. interpole type, 900 r.p.m.
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Turbine: Westinghouse 200 lb. steam pressure, 900 r.p.m., equipped with specially designed governor.

5240 G.P.M. Elliott-Erhart Vertical Jet Condenser

1—5240 G.P.M. Elliott-Erhart No. 9 Vertical Jet Condenser with centrifugal pump, 35-ft. head, direct connected to 200 H.P. General Elec. type I, form K, 3 ph., 60 cy., 2200 v., 48 amp., 875/900 r.p.m., including control apparatus.

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2—150-hp. Gen. Elec. Type 1 Form M 220/440 volt 580 r.p.m.
1—104 hp. Gen. Elec. 1 Form M, 220/440 volt, 860 r.p.m.
1—100-hp. Burke Elec. Type EMV, 2200 volt, 900 r.p.m.
1—75-hp. Gen. Elec. Type MT, 220/440 volt, 860 r.p.m.

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5 New Westinghouse 3 Bearing, A.C., Type G, 50 Kva., 220 v., 3 ph., 60 cy., 1200 r.p.m., D.C., Type SK-150L, 125 volt.
2—Sets as Above Except D.C., SK-150, 250 volt.

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Slip Ring Motors

H.P.	Make	R.P.M.	Ph.	V.	Type
300	Allis-Chal.	900	3	440	ANY
200	Fairbanks-M.	600	3	440	
175	Allis-Chal.	600	3	550	ANY
150	G. E.	600	3	220	I.M.
100	Westghse.	600	3	550	C.W.
100	Allis-Chal.	600	3	440	ANY
100	Westghse.	580	2	220	C.W.
50	Allis-Chal.	720	3	220	ANY
40	Lincoln	720	3	220	IXL
40	Allis-Chal.	900	3	220	ANY

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1—**TURBINE** Ser. No. 10138, Kw., 2,000, Speed, 3600 r.p.m., Form E, Steam pressure, 175-lb, Condensing Generator, Gen. Elec. Co. make, Ser. No. 636519, Type ATB 2—2500 Kva., Speed 3600, Form T, Amp. 361, P. F. 80% Kw. Load 2,000. Volts no load 4,000. Volts full load 4,000. Separately excited—no exciter on Generator. Price, $15,000, as is; f. o. b. Washington St., Utica, N. Y.

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6250 kw. Westinghouse, 2-3-60-2300-13200.
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1500 kw. Gen. Elec., 2-3-60-2200.
750 kw. Gen. Elec., 3-60-600.
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250 kw. Kerr-Diehl NEW 125 volts D.C.

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4—604-hp. Straight Tube B. & W. A.S.M.E. 200 lbs.
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1—17-in. and 10-in.x15-in. Worthington Feed Water Pump.

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5,930 cu.ft. Ingersoll Rand PRE-2, 3 ph., 60 cy., any voltage.

Also many other compressors, electric, steam and belt driven.

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400 kva., 3-60-2300 Gen. Elec. Generator, 514 r.p.m.
360 kw., 3-60-2300-550-440-220 Gen. Elec. Generator, direct connected to a 23x26-in. stroke, left hand Skinner Automatic Engine.

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2—1,000 kva. Turbines, 6,600 volt, 3 phase, 60 cycle.
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2—100 kw. Turbines, 600 volt, 3 phase, 60 cycle.
1—200 kw. Turbine, 440 volt, 3 phase, 60 cycle.

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1—100 kw. Turbine, 125 volt, 800 ampere.
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2—35 kw., motor driven, 92 volt, 380 ampere.

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HIGH GRADE STANDARD EQUIPMENT

Slip Ring Motors—3 Ph., 60 Cy.

Hp.	Volts	Make	Speed
225	220-440	G.E.	450
150	220-440	G.E.	720
150	220-440-550	G.E.	600
125	2200	G.E.	1200
125	220-440	G.E.	600
100	2200	G.E.	900
100	440-220	G.E.	720
100	440-220	G.E.	600
100	440-220	G.E.	900
75	220-440	G.E.	720
75	440-220	G.E.	900
75	550	G.E.	720
75	550	G.E.	900
50	220-440	G.E.	900
50	550	G.E.	720
40	220-440	G.E.	1200

Synchronous Motors—3 Ph., 60 Cy.

Hp.	Volts	Make	Speed
240	2200-440	G.E.	720
135	2200-550	G.E.	900
80	2200-440-220	G.E.	1200

Direct Current Motors

Hp.	Volts	Speed	Make	Type
225	230	635	Westghse.	SK
00	230	625	Westghse.	SK
60	230	1050	General Electric	RC

Direct Current Motors (Cont.)

Hp.	Volts	Speed	Make	Type
50	600	1450	Westghse.	SK

Direct Current Generators

200	250	850	Westghse.	SK
125	575	800	General Electric	C.D.
100	250	720	Westghse.	SK
75	250	1100	General Electric	RC
50	250	1250	General Electric	RC
35	125	850	General Electric	DLC
6	125	300	Westghse.	SK

Sq. Cage Motors—3 Ph., 60 Cy.

200	4600-2300	Westghse.	1800
200	2200	Westghse.	600
150	2200	Westghse.	720
150	220-440	Westghse.	600
100	220-440	G.E.	600
100	220-440	G.E.	720
100	550	G.E.	720
100	220-440	G.E.	1200
100	220-440	G.E.	900
75	220-440	G.E.	900
75	220-440	G.E.	720
75	220-440	G.E.	1200
75	2200	Allis-Chal.	1200
60	220-440	G.E.	900
60	220-440	G.E.	1200

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1—200-kw., 250-v., 900-r.p.m. Westghse., SK connected to 2200-v., 3-ph., 60-cy., syn. motor.
1—165-kw., 125-250-v., 6-ph., 60-cy., 1200p-r.p.m G.E. with 2300-4000-v., 3-ph. transformer.
1—50-kw., 125-v., 1150-r.p.m. Wghse.S, K, D. C Generator, connected to 75-hp. Wghse., type CS, 2200-v., 3-ph., 60-cy. motor.

A. C. Generators—3 Ph., 60 Cy.

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1—200-kva., 600-r.p.m., 2300-440-220-v., G.E.
1—187-kva., 720-r.p.m., 2200-440-220-v. G. E.
1—100-kw., 900-r.p.m., 2200-v. G. E.
1—75-kw., 900-r.p.m., 480-240-v. G. E.
1—75-kw., 1200-r.p.m., 2200-480-240-v. G. E.
1—37½-kva., 1200-r.p.m., 240-v., G. E.

Transformers

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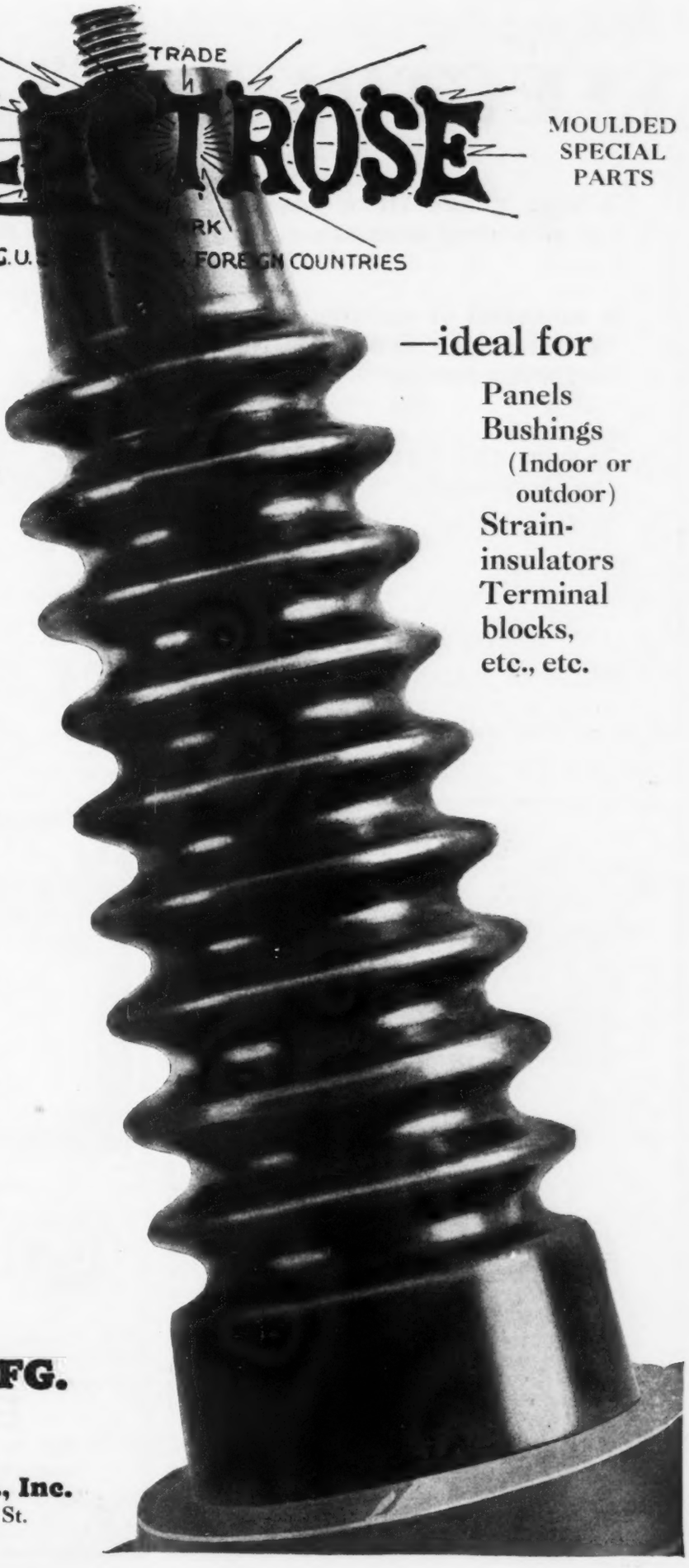

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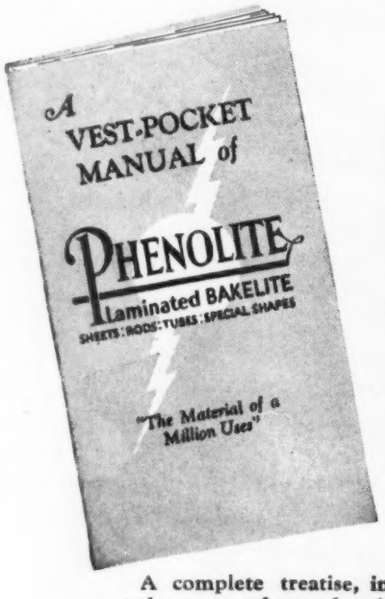

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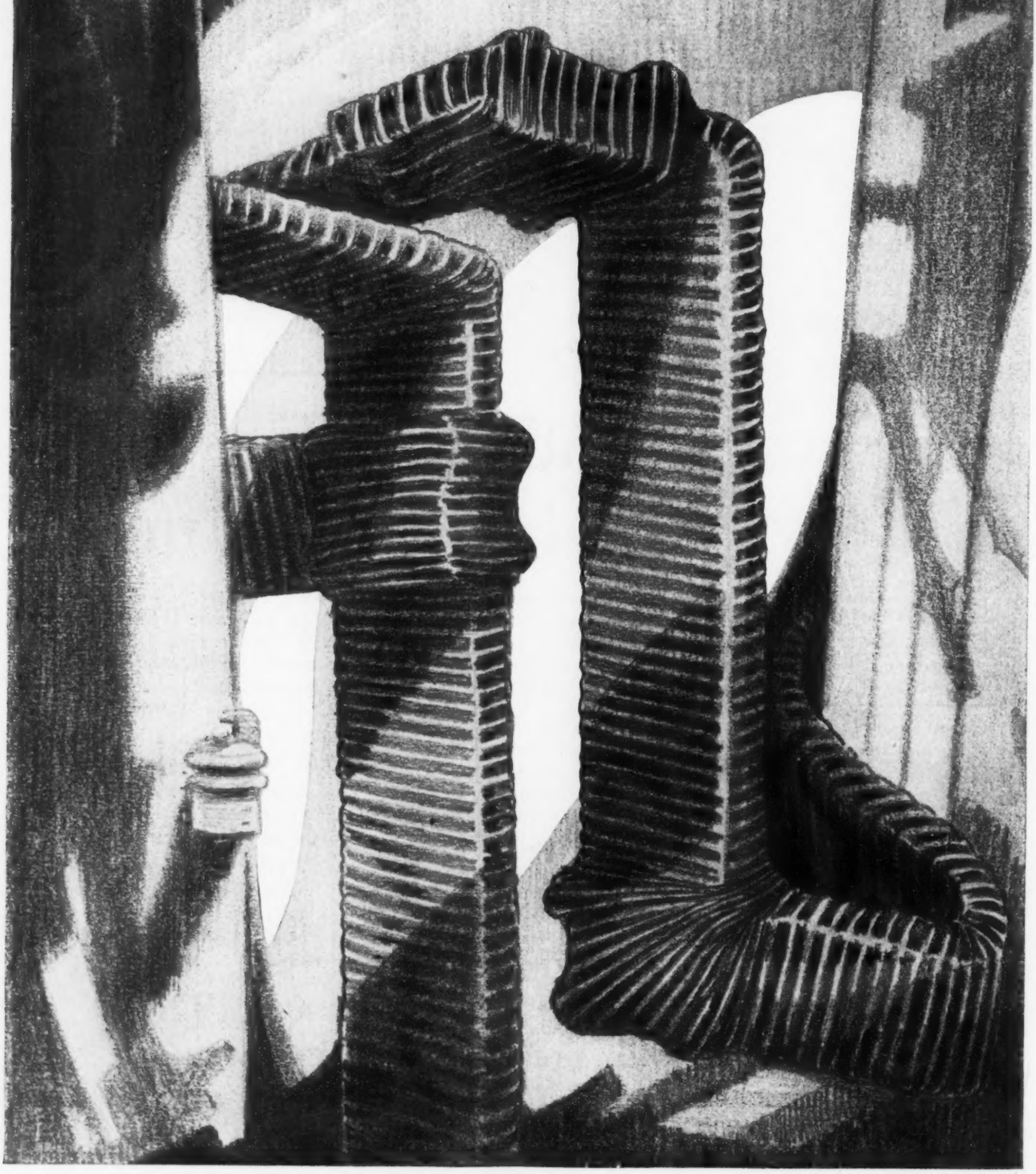

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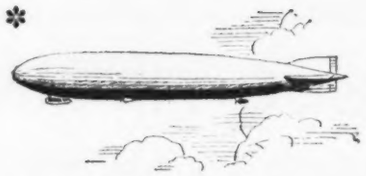

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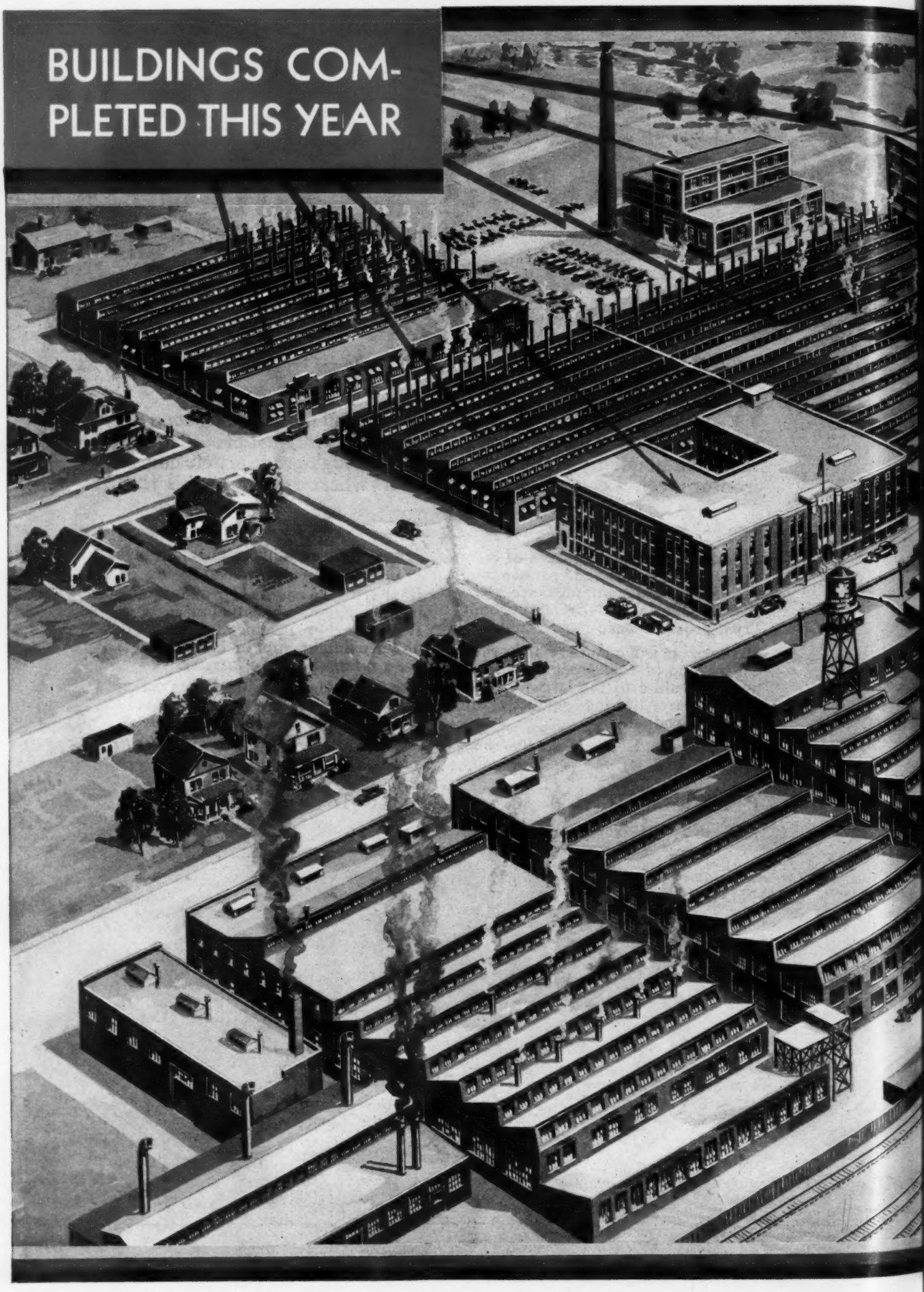
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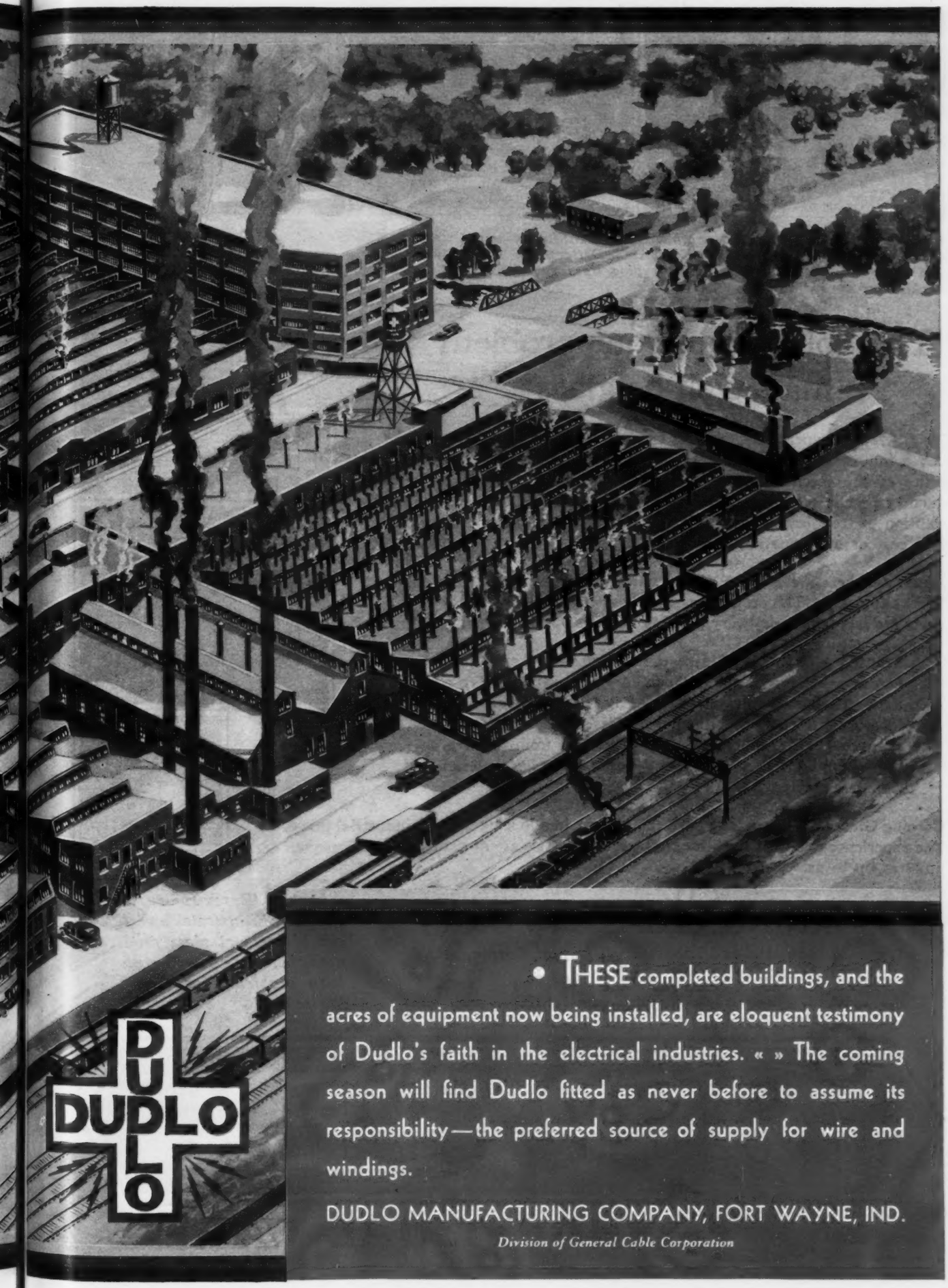

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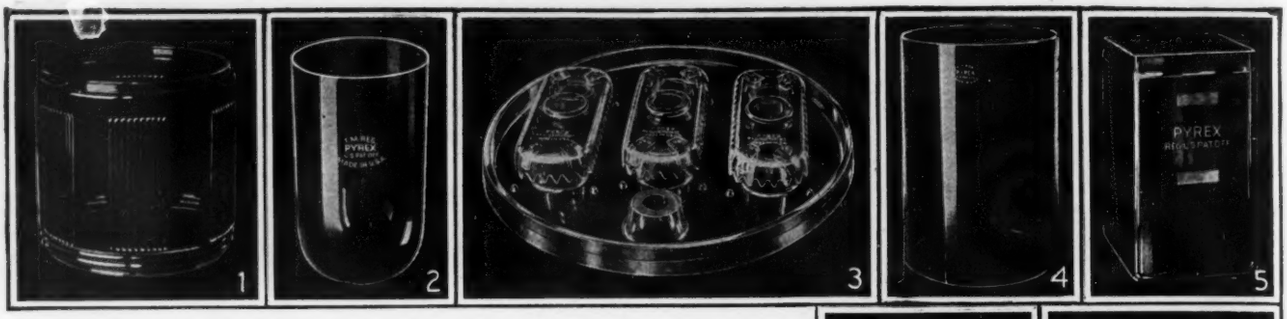

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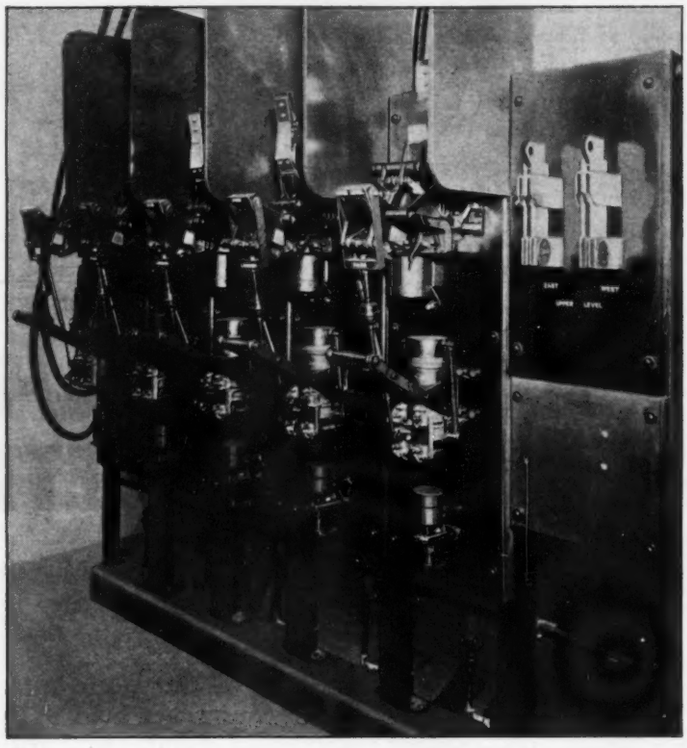

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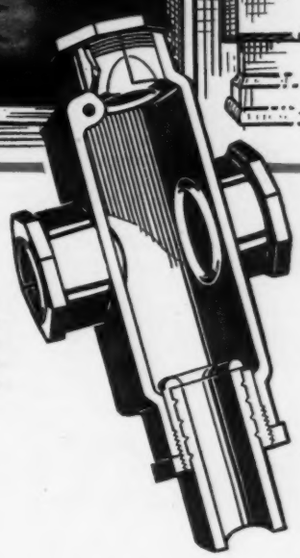

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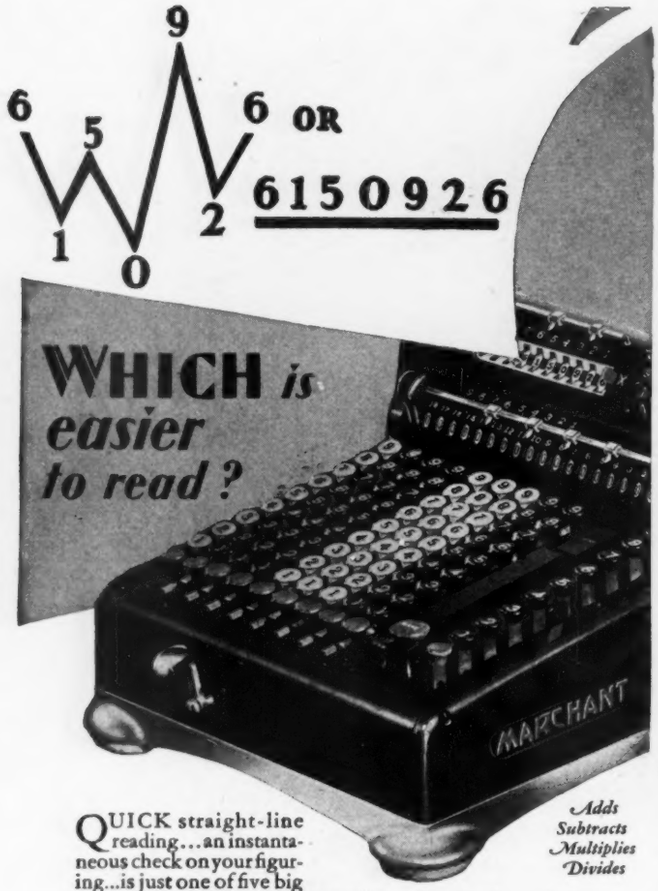

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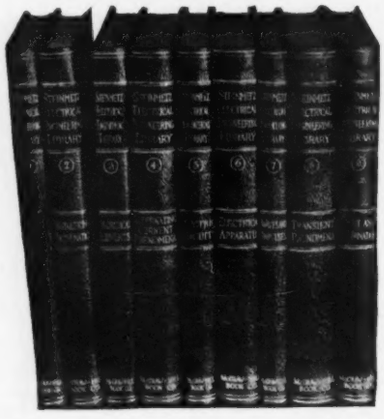

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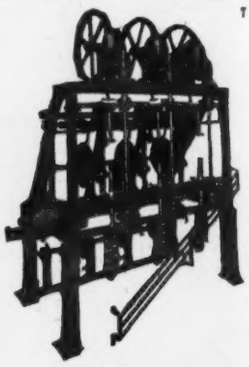

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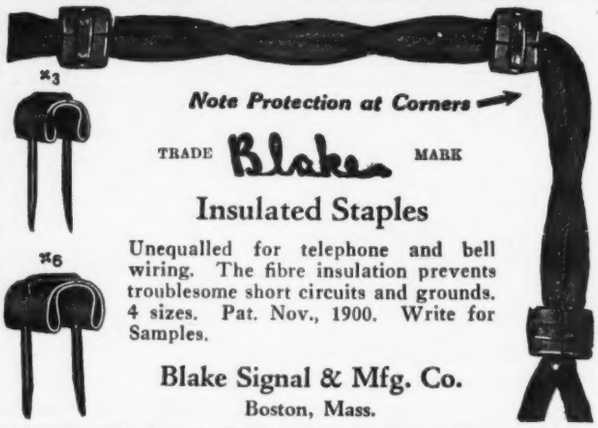

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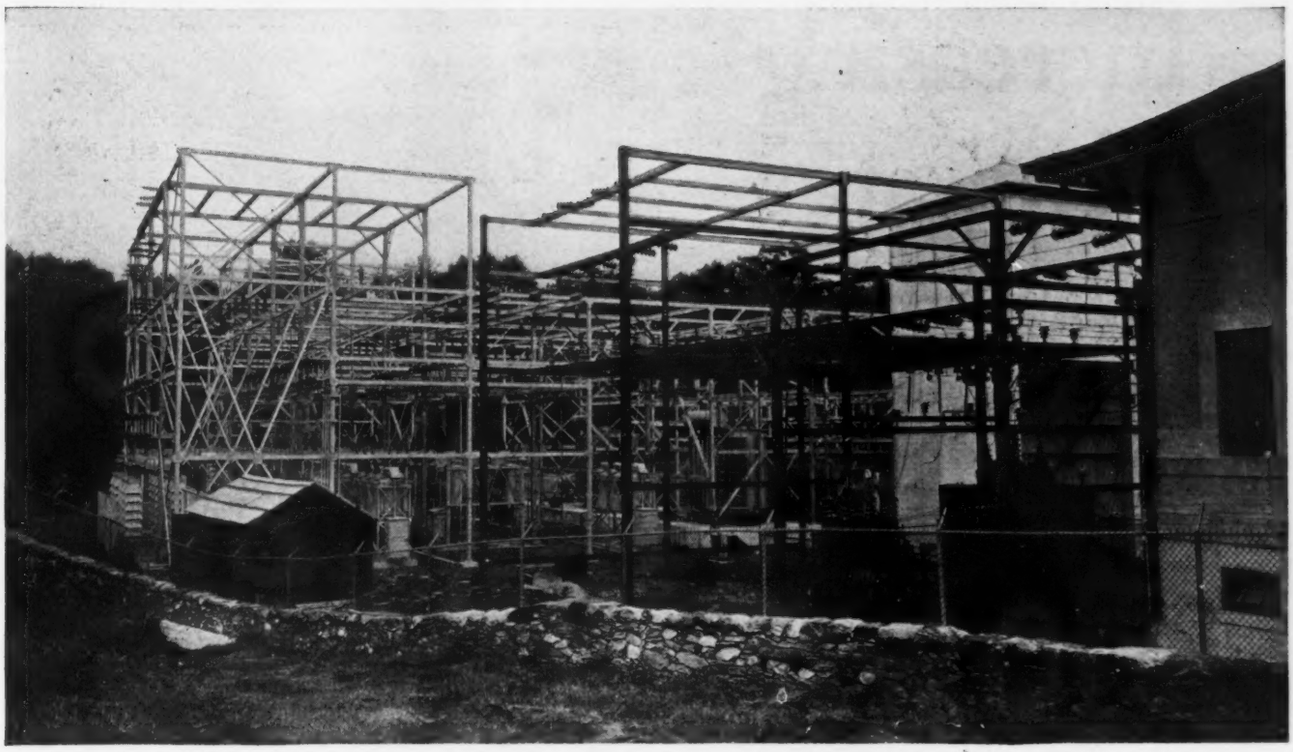

One of several switching yards of Westchester Lighting Company, built of Lehigh Steel.

A good start – Lehigh Steel

Strength and security of construction make a good start toward economical operation of high tension transmission lines, substations and power plants.

Lehigh Steel insures sound construction. It is instantly specified for towers, substations, power plants, coaling stations and office buildings by such concerns as Stone & Webster, Inc., W. S. Barstow Management Ass'n., J. G. White Engineering Corp., Phoenix Utility, E. L. Phillips & Co., and others.

Prompt, efficient service from experienced Lehigh Engineers will help you in planning and erecting your next construction job.

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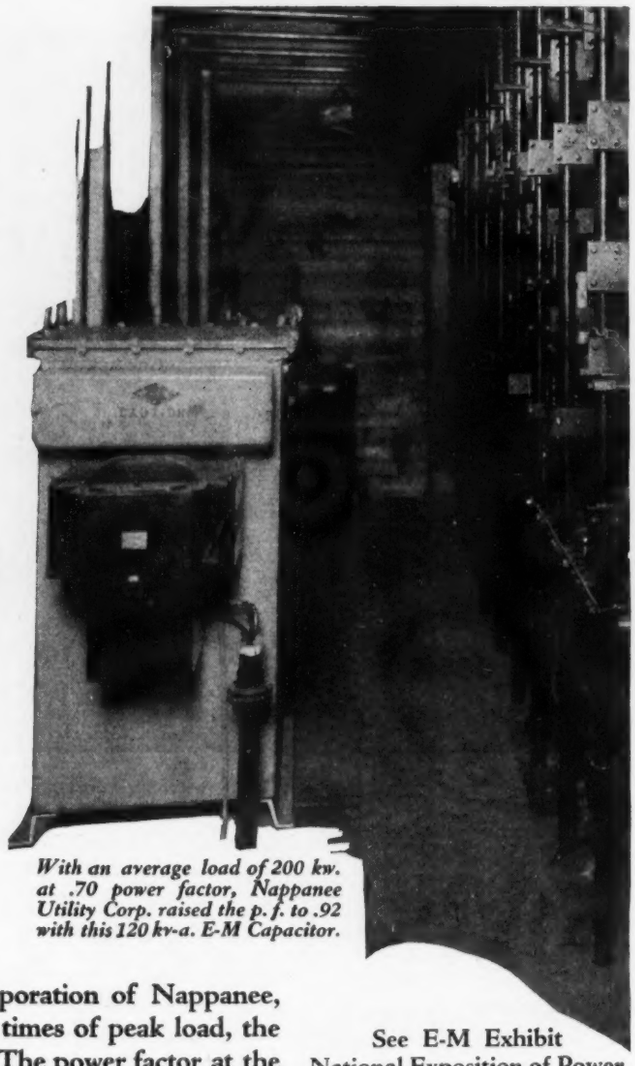
Increasing Generator Capacity *for Central Stations and Private Plants*



With an average load of 200 kw. at .70 power factor, Nappanee Utility Corp. raised the p. f. to .92 with this 120 kv-a. E-M Capacitor.

THE load of the Nappanee Utility Corporation of Nappanee, Ind. had gradually increased until, at times of peak load, the capacity of the generators was exceeded. The power factor at the generator terminals was but .70—only 7/10 of the power produced was useful kw. and there was a large amount of undesirable reactive kv-a.

The 120 kv-a. Capacitor shown, was installed in back of the switchboard to supply most of the reactive kv-a.—the power factor is now .92—another generator is unnecessary—and voltage regulation is better.

Public utilities install E-M Capacitors either at the ends of lines or at the generator; industry distributes them throughout the plant or in the power house—the result in any case is more efficient service from existing equipment and postponement or elimination of the need for more.

See E-M Exhibit
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There is an E-M power factor specialist near you. He has been thoroughly trained in this subject, can analyze your needs exactly and knows how to correct any conditions that cause low power factor. Your calling him in for complete information involves no obligation.

Electric Machinery Mfg. Company
Specialists in Apparatus for Power Factor Improvement
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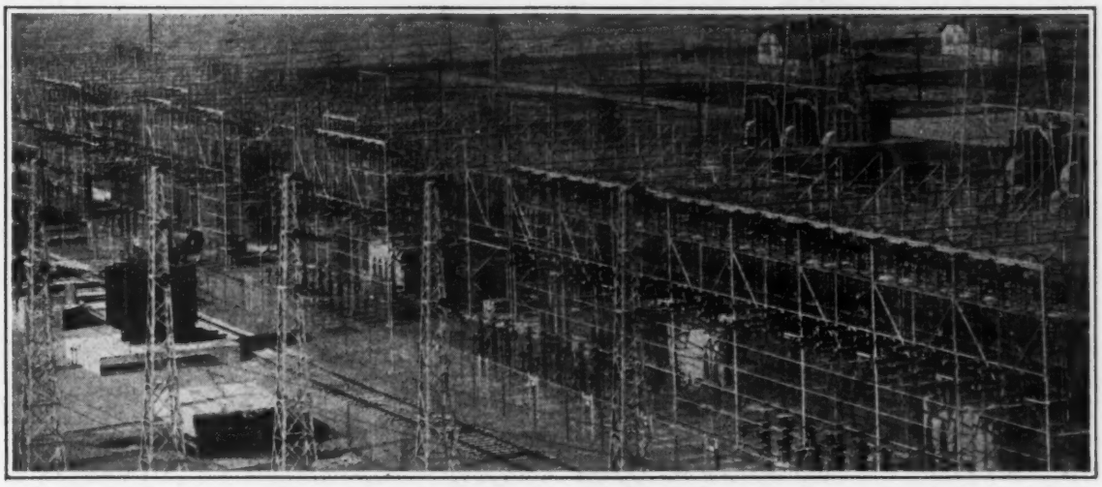
EM *Power Factor Improvement* **CAPACITORS**

STATIC CONDENSERS FOR GENERATOR POWER FACTOR CORRECTION

(4071)

Cutting Costs of Substation Construction



Lighthipe station of the Southern California Edison Company, at the terminus of its 220-Kv. transmission system. This company has given great study to the problem of standards in substation design and through this has effected marked economies in construction costs.

This station is equipped with 57

NIAGARA AIR INSULATED CURRENT TRANSFORMERS

Mounting Arrangements

As an aid to engineers engaged in substation layout work we have prepared drawings showing various mounting arrangements for Niagara Air Insulated Current Transformers. Copies of the complete series will be mailed on request.

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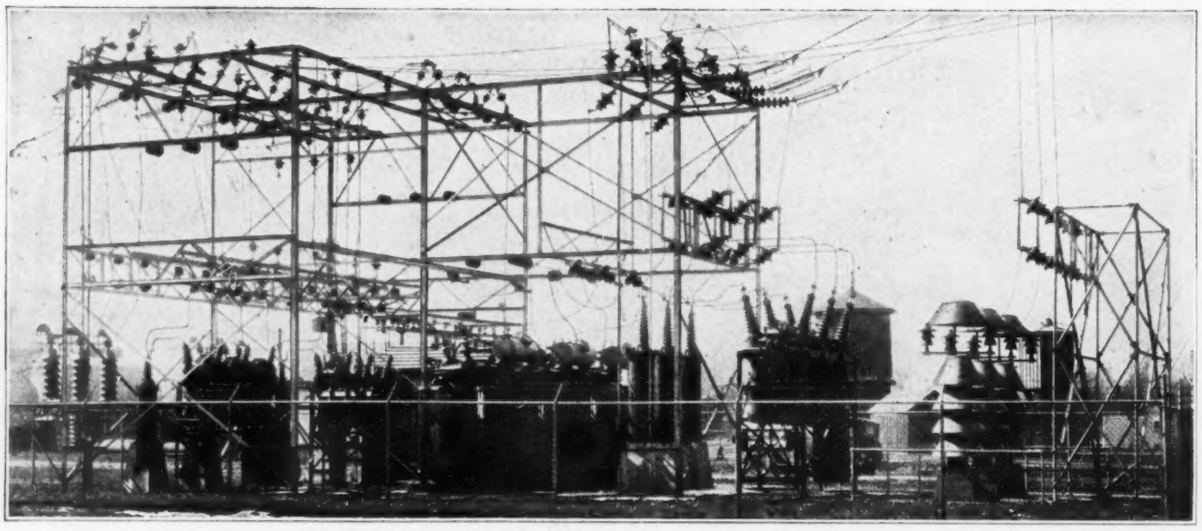
dependable under every operating condition



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When planning a substation think of your investment in terms of individual units and not just the assembled station. In that way you insure economical service over a long period of time. Let "Three E" engineers help you.

Why worry about the details of the outdoor substation? Put the problem up to "Three E" and let us work out the proper solution. This organization is always at your service.

*"Service Value" = Low cost per year of service

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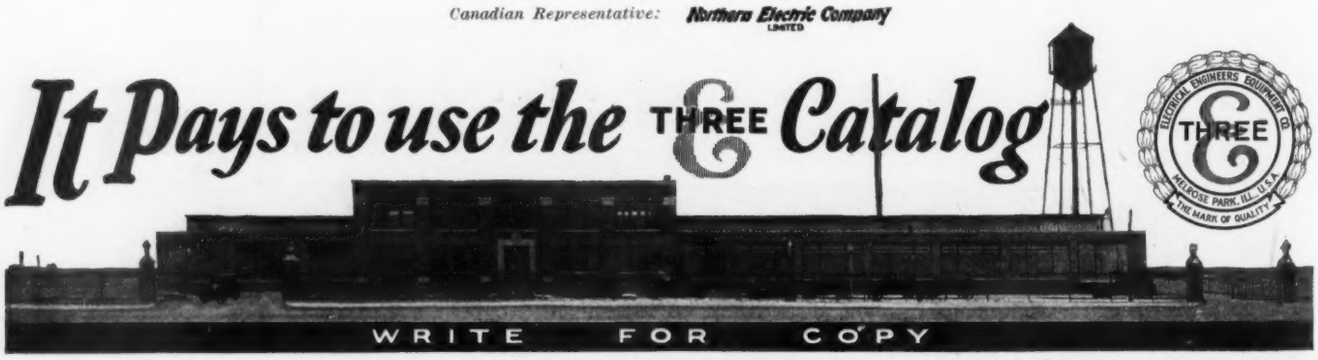

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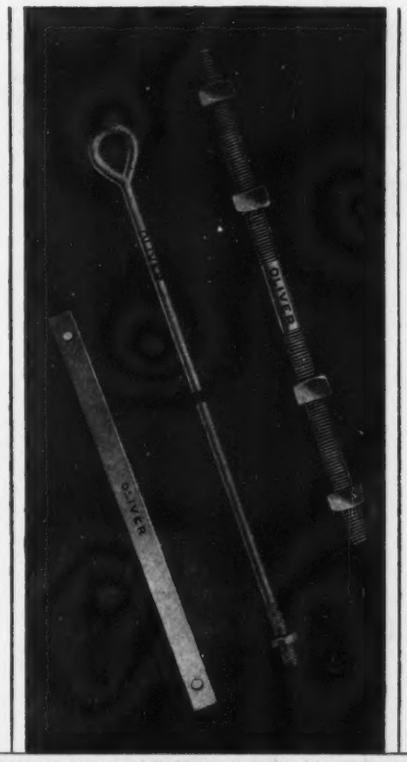

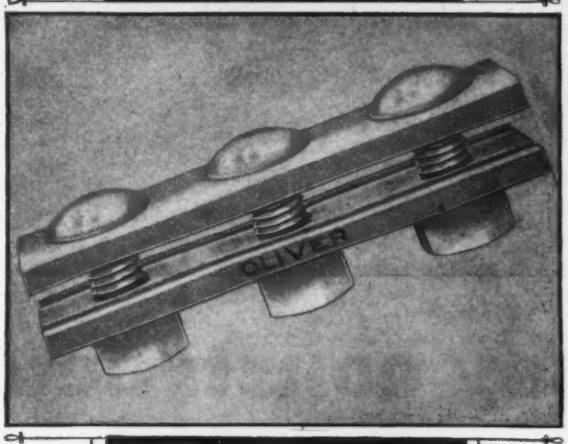

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You can place implicit confidence in Oliver Pole Line Materials. The shape, size, threading, finish and tensile strength of each and every piece is made to meet the strictest specifications. All are standardized to assure absolute uniformity.

Exacting standards of manufacture—modern machines and precision methods all combine to assure absolute uniformity from one end of the year to the other. With Oliver Pole Line Materials, replacements and repairs can thus be made with dispatch—all parts fit and the threaded pieces are always clean and perfectly threaded.

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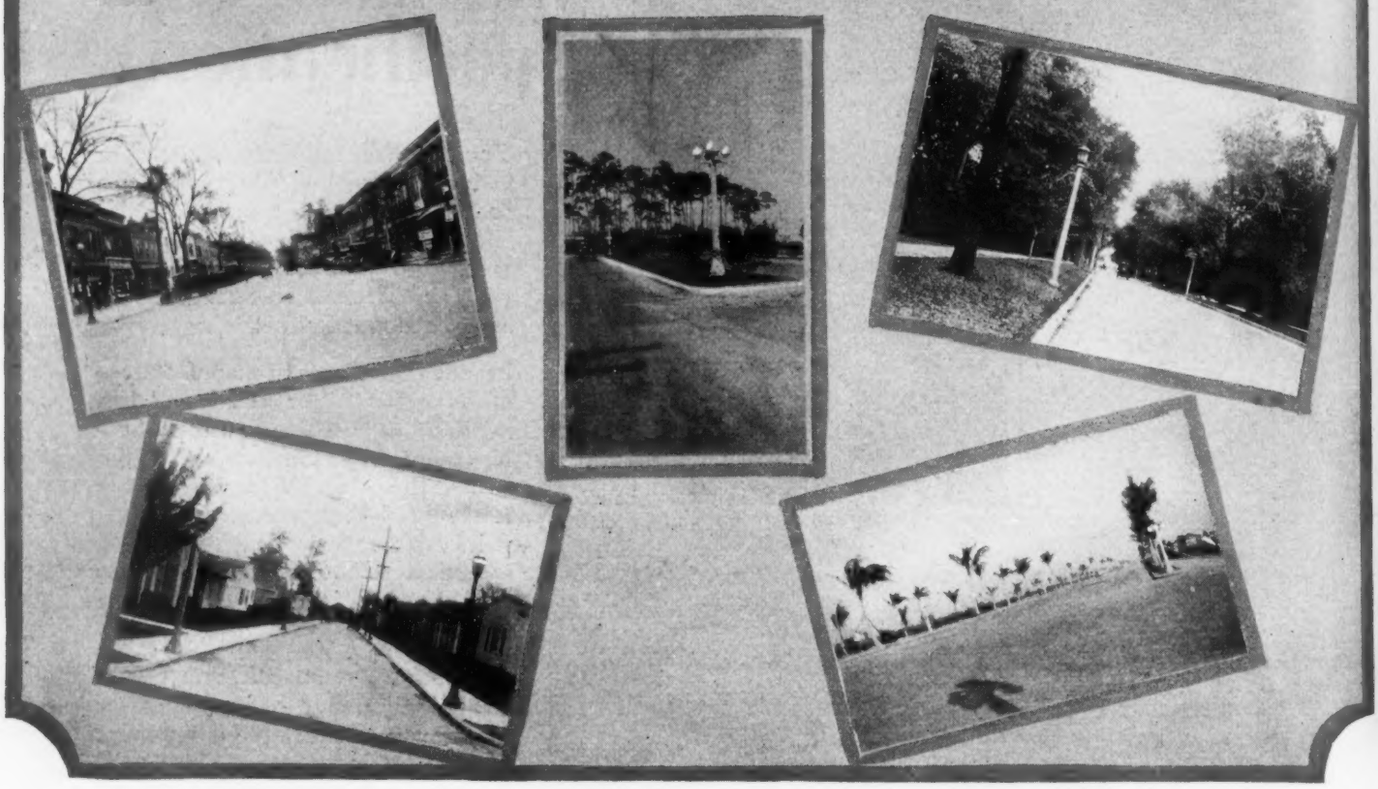
for underground



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For parkways it is only necessary to,

1. Dig a shallow trench.
2. Lay CONDEX in it.
3. Replace the earth and turf.

For paved streets, it is necessary first to take up paving blocks and after CONDEX is laid in the trench to replace them.

Get a piece and examine it.

Two CONDEX Advantages

1. It offers unusual resistance to crushing.
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FIBREX TREE WIRE
for overhead

Protects lines through trees

To install Fibrex Tree Wire, it is only necessary

1. To locate bare spots caused by wire rubbing on the limbs of trees.
2. Splice in a few feet of FIBREX Tree Wire.

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1. It offers real protection.
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Test PAGE *preformed* Strand *for yourself*

It outperforms because it is preformed

YOU can have a sample of Page *Preformed* Strand to test the *preformed* construction for yourself — prevents kinking and unstranding—makes splicing simpler—eliminates salvaging of ends —requires no seizing. Dead-end fasteners are more easily attached.

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Preformed Strand and Tru-Loc Fittings are patented and manufactured under license arrangements with the American Cable Company, *Inc.*

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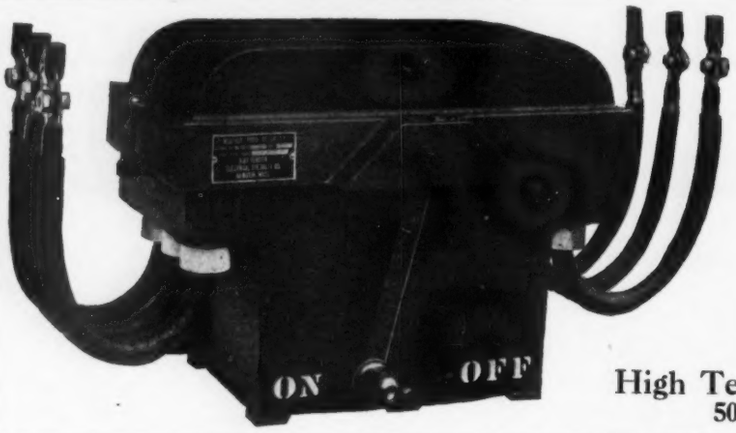

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Leads and connecting lugs standard equipment, items often overlooked in estimating final costs. This type of switch on the market for over 25 years.

Rugged Construction
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Ample Carrying Capacity

TYPE B.A. & E.A. made in sizes 75 to 300 amperes, 3000 to 5000 volts; 1, 2, 3 and 4 Pole. Our Bulletin No. 11 lists these and other types up to 200 ampere, 7500 volts.

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Paragon Grounds

Furnish permanent, effective grounding protection.

Heavy continuous copper throughout. All joints spot welded. Insure durability, highest conductivity, lowest resistance to ground, and ample capacity. Inexpensive and easily installed with a post hole auger.

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Specializing

High and Low Voltage Insulators

GALVANIZE IT!

We have the largest hot dip job galvanizing plant and kettles in the United States.

We have the most modern equipment to do first class galvanizing at lowest prices. Send prints.

Galvanized products furnished.

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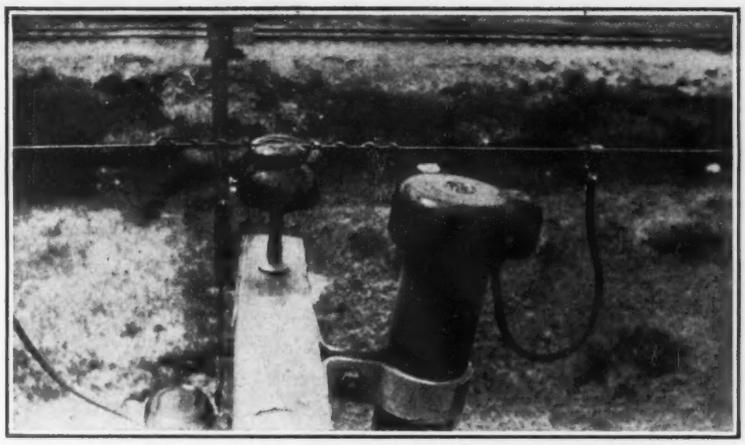
Gaul & Letterly Sts., Philadelphia, Pa.

A Lineman's View of DOSSERTS



This view taken from the top cross arm shows one of 1500 DOSSERTS installed on lines of Los Angeles and Salt Lake Railroad Company (Union Pacific System).

This Dossert year book gives data on dozens of connections on which linemen and wiremen can save time and provide dependable joints.

FOR 20 years engineers have found DOSSERTS a means for economical and dependable joints and terminals for wires, cables, rods or tubing.

The reason for the choice of Dosserts is purely an engineering one i.e.—the Dossert tapered sleeve principle.

But the lineman's view of the Dossert is always that it saves time and labor in the effort to make good connections.

DOSSERT & COMPANY, H. B. LOGAN, *President,* **242 West 41st St., New York**

DOSSERTS

SHEDS WATER LIKE AN UMBRELLA

This new L-M Capnut completely covers the threaded stud and keeps the water out—also seals against compound leakage. All nuts exposed to the weather have shoulders projecting upward into the nut immediately above—water can not pass over these shoulders.

L-M Potheads are made for indoor and outdoor service, for one, two, three and four conductors for any application. Any type can be assembled immediately from standard interchangeable parts.

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We make what you want made

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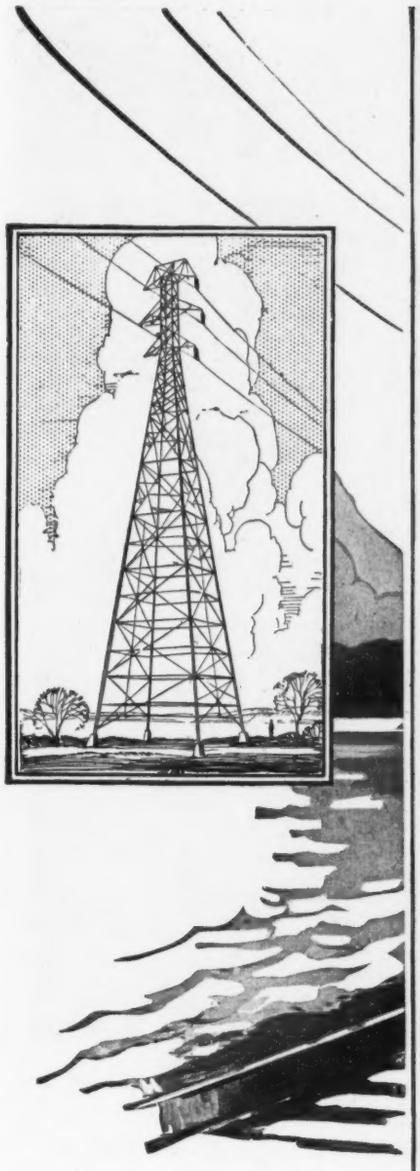
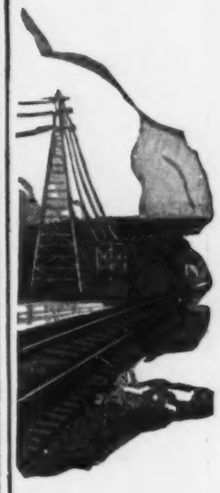


A 2230-foot span *of* ANACONDA COMPOSITE CABLE over the Platte River



THE illustration shows a transmission line of the Nebraska Power Company where it spans the Platte River, paralleling the Missouri Pacific Railroad.

Anaconda Composite Cable comprised of nineteen wires—7 Hitenso BB, and 12 Red-Brass, was selected for this 2,230-foot span. The cable has an outside diameter of .555 inches and a minimum breaking strength of 18,400 lbs. with a hard drawn copper equivalent conductance of 106,300 c.m.

This installation is a typical application of Anaconda High Strength Composite Cable, demonstrating the ability of Anaconda to supply special cables to meet exacting engineering problems.

Electrical Engineers are invited to consult our engineering department in regard to the design and construction of cable to meet special requirements.

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General Offices: 25 Broadway, New York
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Exclusive Selling Agent for Wire and Cable Products of
THE AMERICAN BRASS COMPANY

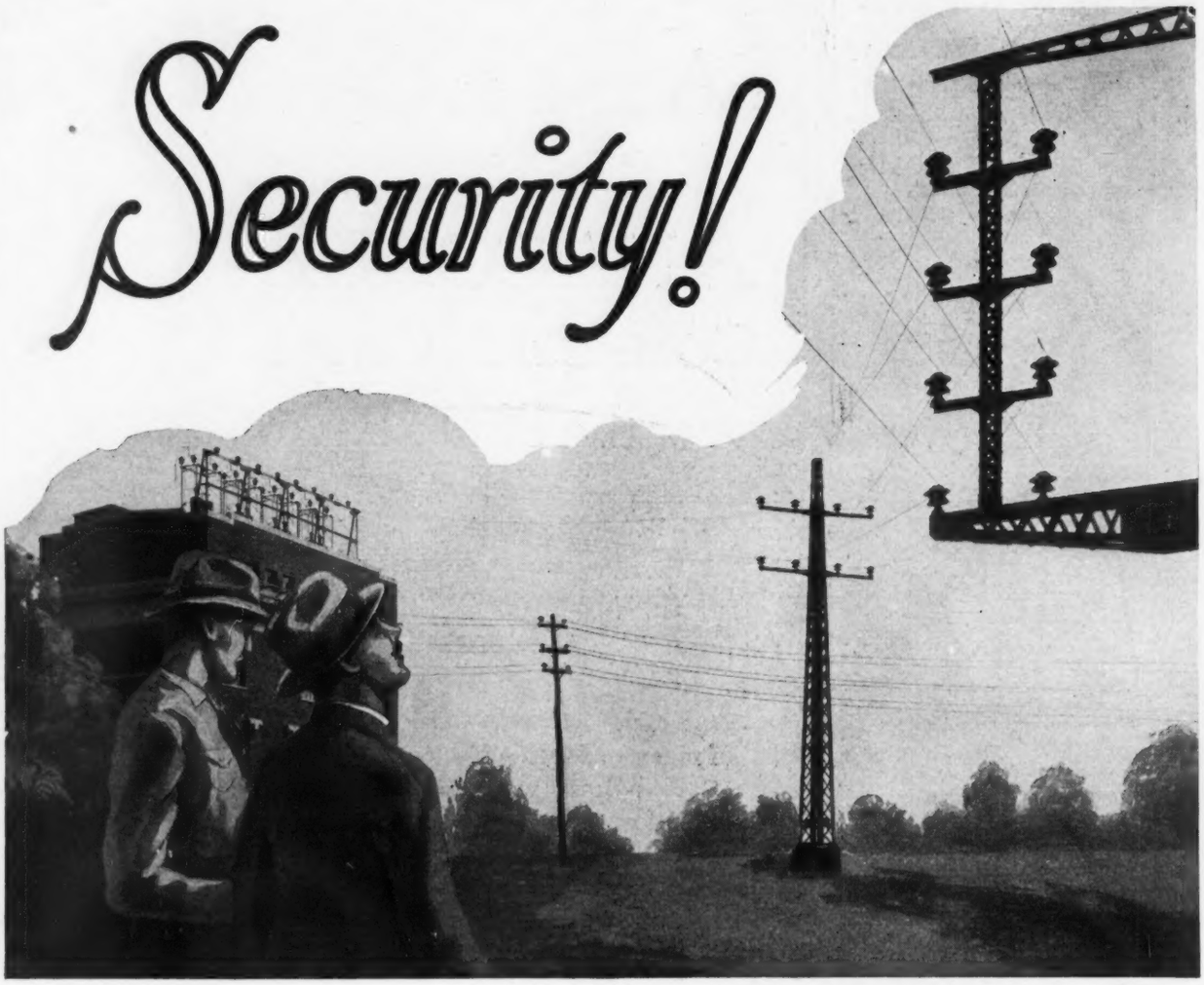
ANACONDA
from mine to consumer

The high conductivity and uniform quality of Anaconda Metals are the result of the coordinated supervision by a single organization of every process from ore to finished product.

Seven wire mills offer a coast-to-coast service unequalled for promptness and dependability.

ANACONDA WIRE PRODUCTS

Security!



USERS of *Thomas Insulators* have learned from actual experience that their purchase includes something more than mere porcelain; they buy *Security*, as well. *Insulator Security* means a carefully made product, and faithfully tested; it means a rugged design that will transport safely, and one that will stand rough handling during line construction; it means the ability of the porcelain structure to withstand malicious abuse from the hands of playful boys and disappointed hunters; it means an insulator that will live through the attacks of lightning and the *power arc* without failure; it means a support for your conductors that will carry on through the years without being responsible for any interruption in the steady flow of your product—*electric power*.

There's a real purpose behind the ruggedness of *Thomas Insulators*. The *Pioneer's* product is at all times designed to insure a very generous safety factor, always in excess of the buyer's specifications. *Thomas Insulators* will withstand the most rigid laboratory tests but better than that they will perform in actual line service beyond the most extravagant expectations. Briefly, that is the history of *Thomas Insulators*.

Just check up on the record of *Thomas Insulators* in your own vicinity, on your own lines. You will find that *Thomas* installations are not only the oldest in yearage but the most faithful and dependable in line service.

When you have a perplexing insulator problem, call in a Thomas Field Service Engineer.

THOMAS INSULATORS

TRIED TESTED

NEW YORK ~ BOSTON
GRAYBAR ELECTRIC CO. Inc.
ON THE PACIFIC COAST.

THE R. THOMAS & SONS CO.
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PIONEERING SINCE 1873

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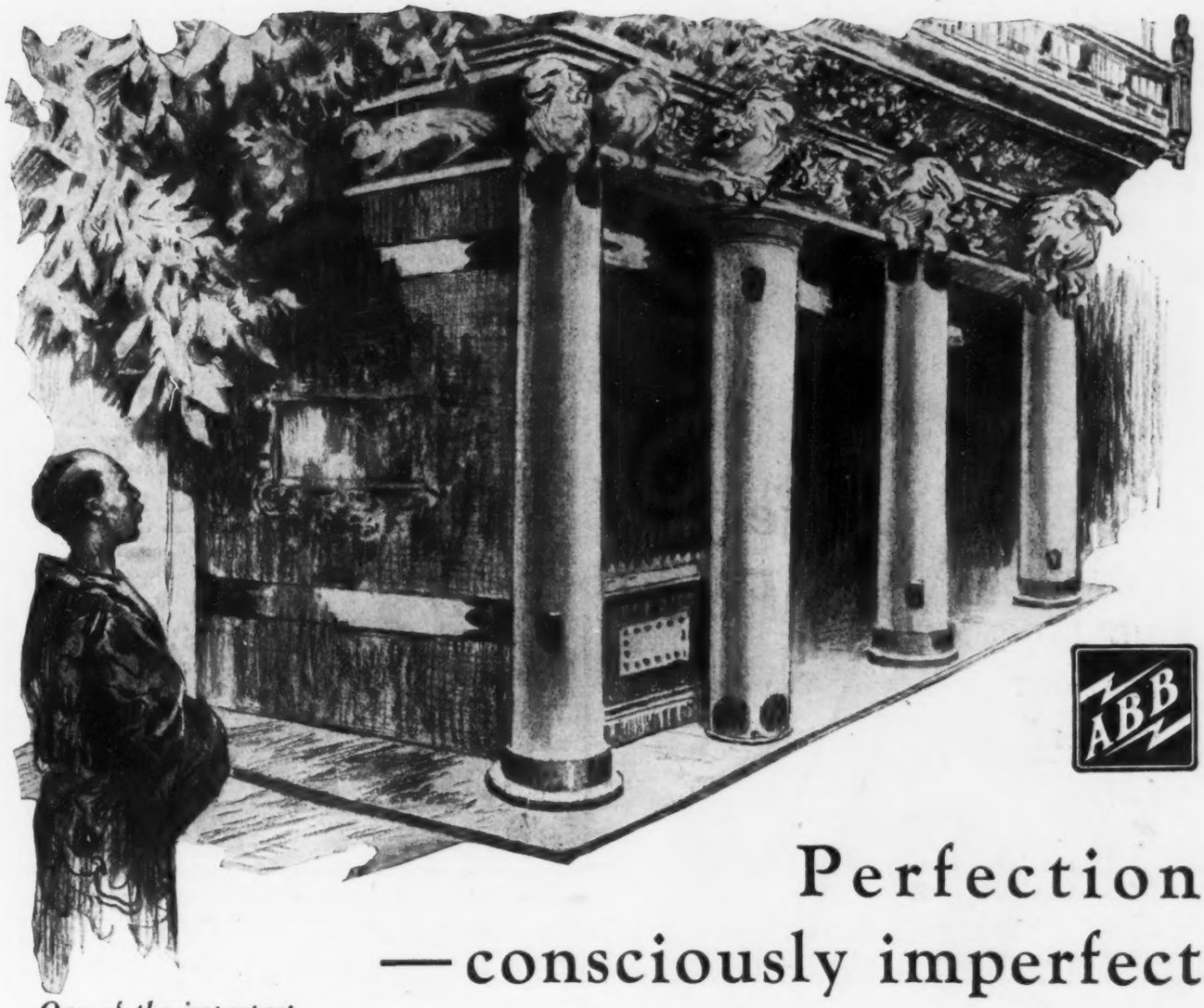
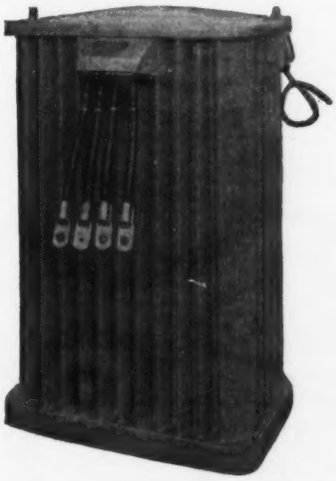
NORTHERN ELECTRIC CO. Ltd.
IN CANADA



Perfection —consciously imperfect

One of the important little things

Wet-process porcelain is used for all transformer bushings—even in the case of the low voltage distribution units.



At Nikko, Japan, stands a gateway to the temple of the Yomeimon. So perfect is it in its incredible wealth of sculptural tracery, that its builder feared the envy of the gods, for they alone may aspire to perfection.

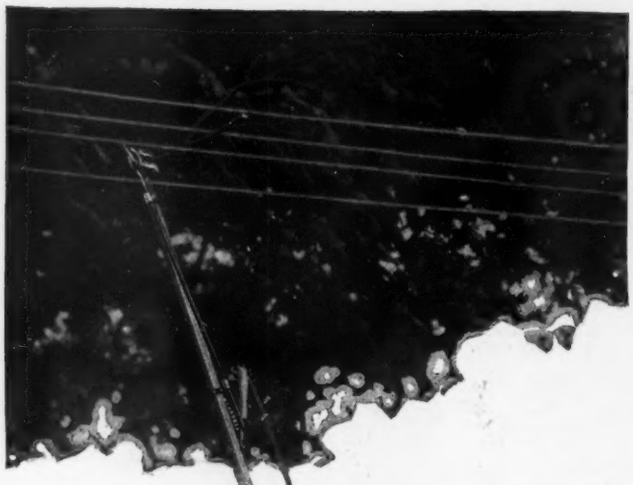
Accordingly, one of the main pillars was turned upside down—perfection made consciously imperfect.

American Brown Boveri has never built a transformer so perfect that the envy of the gods would be aroused. Perhaps that day will never come.

But American Brown Boveri is earnestly striving for perfection. The formula is simple—unending and unswerving devotion to the "important little things". Thirty-eight years of Brown Boveri experience in Europe plus thirty-nine years of Packard experience in the United States have brought to light most of the little things that have needed perfecting.

AMERICAN BROWN BOVERI CO., INC.
CAMDEN, N. J.

AMERICAN BROWN BOVERI



Safety First!

Protect Your Lines and Your Linemen

YOU know it's necessary to keep limbs and branches away from your lines—but are your men provided with the best, safest equipment while doing it?

Bartlett Tree Trimmers

have a compound lever blade that cuts through 1¼ in. limbs with ease. The pole is of light weight, airplane spruce in 8 to 16 foot lengths, with extra lengths easily attachable and locked with aluminum sleeves. The Bakelite insulator, tested to 105,000 volts, permits the Bartlett Tree Trimmer to be used around hot wires with safety for the lineman.

For limbs larger than 1¼ in. the Bartlett Pole Saw, illustrated at the left is very efficient. It is equipped with 16-in. blade, seven teeth per inch.

Get full information today. Bartlett Tree Trimmers are used by Light, Power and Telephone companies all over the country.

Endorsed by more than 400 Public Utility Companies and largest tree expert companies.

BARTLETT MFG. CO.

448 E. Lafayette Ave., Detroit, Mich.

NEW Triple Lock Transfer Switch that saves space

It has been developed to meet limited space conditions in certain substations where 13,800-volt construction is used and the line disconnects are mostly conveniently placed above the transfer bar. Existing transfer buses can be used without increasing the cell center spacings. These switches are mounted on single-post insulators and 8 in. steel bases, allowing a very economical cell wiring assembly.

There is a positive lock in the closed position which requires a disengaging operation before the switch can be pulled through the downward operation. Again there is an entirely independent lock at the 90 deg. or clear position which requires another disengaging operation before the blade can be pulled to the new closed position and automatically locked.

Write for full details and quotations.

Thoner & Martens
Electricians and Machinists
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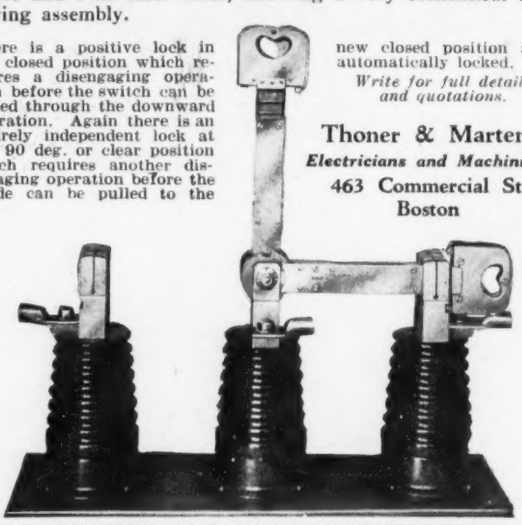

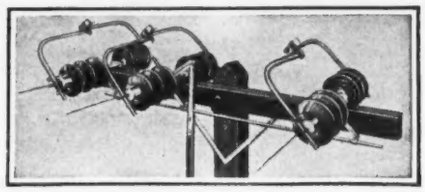

K-P-F Switches for Pole-Top Service

Uninterrupted service is insured by frequently sectionalizing with K-P-F pole-top switches. Many power companies are using these switches with unusual success and economy and are standardizing on them for sectionalizing and disconnecting service.

K-P-F ELECTRIC CO.
855 Howard St., San Francisco, Cal.

SAFETY SWITCHES

Accessible Main Fuse
30 to 600 amps.

30 to 400 amps.
Remote Control
& Automatic Transfer Switches

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WALTHAM, MASS.

"Bates Poles Outlive the Bond Issues that Buy Them"

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Bates Expanded Steel Truss Co.

General Offices and Plants
EAST CHICAGO, INDIANA, U. S. A.

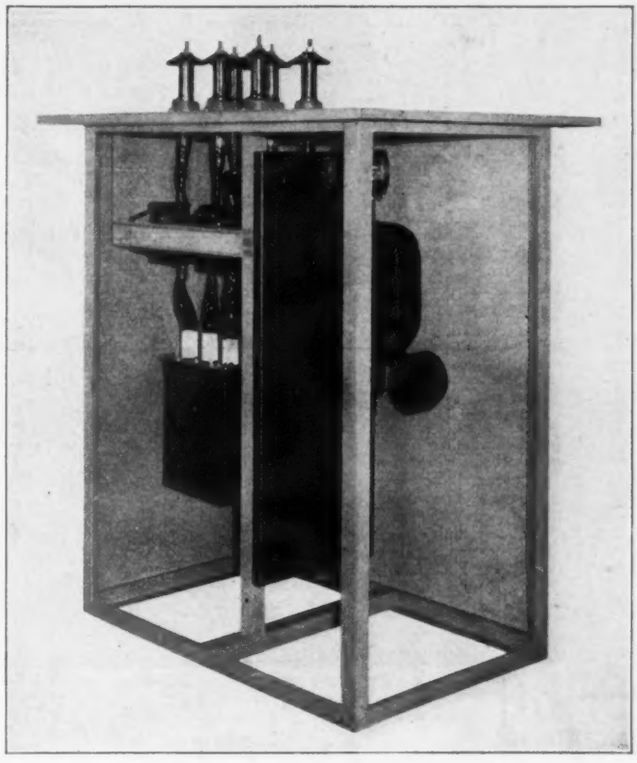
What is your program for 1930?

¶Next year will see renewed efforts to reduce operating costs, and improve service standards.

¶The low tension distribution feeder, that last link between System and Consumer, must be adequately protected by automatic reclosing circuit breakers, to insure 100% service.

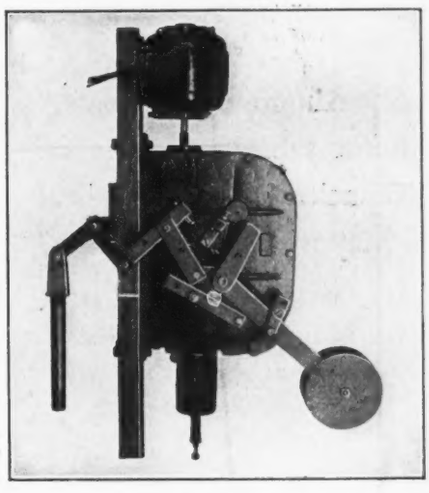
¶Such automatic equipment must be extremely simple in design, positive in action after long periods of idleness, and obtainable at a price which will not seriously affect substation investment.

¶The assembly of protective equipment, metering and relay features in one light compact unit reduces the cost, and eliminates many possible causes of trouble.



Type "TR" Automatic Switching Units

are designed by operating engineers, and meet the above requirements completely. This Company's efforts have made simplified, low cost reclosing available to public utilities thruout the world.



¶The reclosing mechanism used in these units is also available to automatize existing manual breakers, indoor or outdoor.

¶It consists of a simple gear train and linkage, and entirely eliminates delicate timers and relays.

¶The falling weight principle is utilized to give a positive closing action not approached in other designs.

¶Standardization of type "TR" Construction means quick delivery of these units, to which metering equipment and similar apparatus is easily applied.

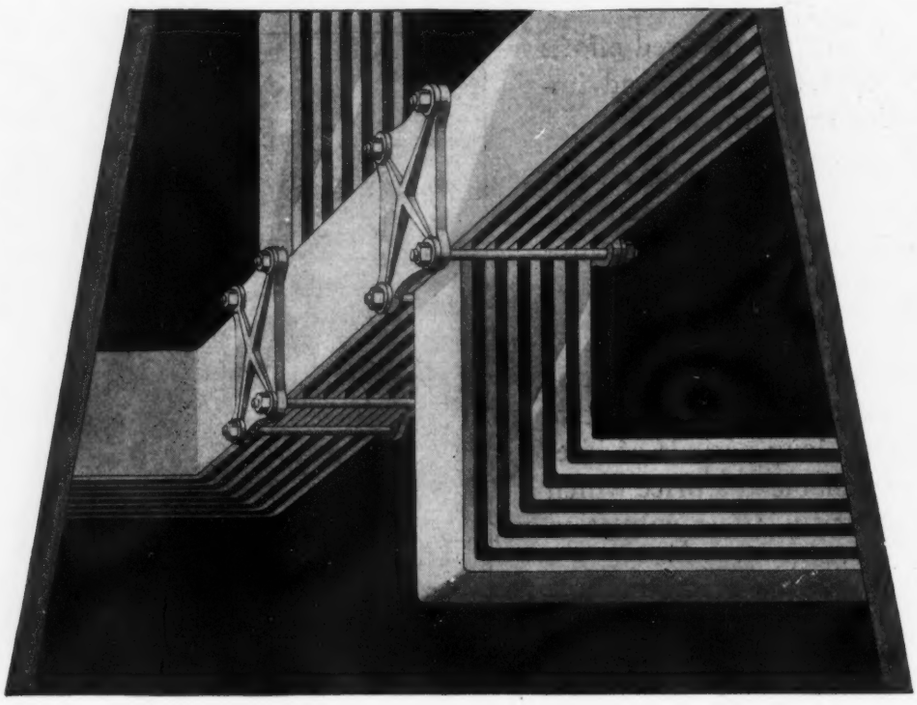
WRITE FOR THE BULLETIN "1930 FEEDER PROTECTION"

AUTOMATIC SWITCH COMPANY

517 East Larned St., Detroit, Michigan

PIONEERS IN THE MANUFACTURE OF RELIABLE LOW PRICED RECLOSING EQUIPMENT

ALCOA



For reliable service..decreased costs .. ALUMINUM BUSBAR

EACH month an increasing number of power companies take advantage of the economies inherent in Aluminum Busbar.

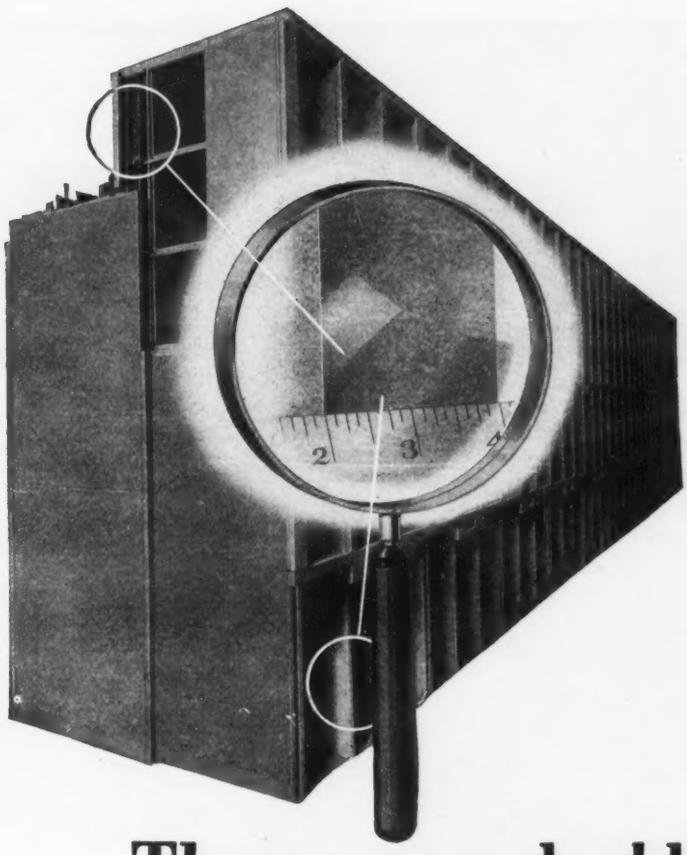
Definite savings in the initial cost of installation, and reliable, dependable, day in and day out service are characteristics of this material. These facts have now become very generally recognized.

A booklet, "Aluminum Busbars," contains useful tables of weights, carrying capacities and physical properties. May we send you a copy?

ALUMINUM COMPANY OF AMERICA
2438 Oliver Bldg., Pittsburgh, Pa.
Offices in 19 Principal American Cities

ALUMINUM

Busbar



Fabricated
of slabs
2 inches thick

They *save* valuable station space!

The new building may be built in smaller dimensions or you may keep it the same size and leave more working space around equipment.

In addition to the saving through reduced floor area, Alberene Stone Compartments, completely fabricated before shipment from the mill, represent a saving of time and money over brick or concrete compartments. Erection is simply a matter of assembling ready-cut parts and requires no skilled labor.

Designs can be as varied as need be to conform with the arrangement of the equipment. Materials and methods are standardized but sizes are exactly in accordance with the layout of the plant.

These are some of the reasons why Alberene Stone Fabricated Compartments (of 2" thick natural quarried soapstone) are replacing brick and concrete structures.

Write for details regarding this basic improvement in compartment construction.

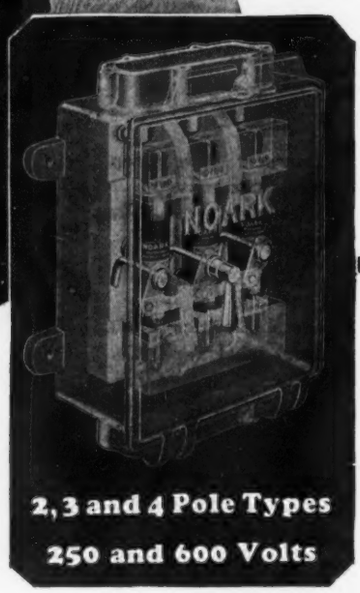
Contracts have been received recently from the following representative companies:

Northern Westchester Lighting Co.
General Electric Company.
International Paper Co.
American Gas & Electric Co.
National Tube Company
Kansas City Power & Light Co.
Pittsburgh Plate Glass Co.
United Railways & Electric Co.
New England Power Construction Co.
Metropolitan Electric Co.
McLauren Paper Co.

ALBERENE STONE COMPANY
153 West 23rd St., New York
Branches: Boston, Chicago, Philadelphia, Newark, N. J., Pittsburgh, Rochester, Cleveland, Richmond, Washington, D. C.

ALBERENE STONE COMPARTMENTS

Noark
Service Boxes



2, 3 and 4 Pole Types
250 and 600 Volts

Can you beat this?
—For Underground Services

A NOARK Cast Iron Service Box giving you a fused cable terminal and emergency cutout and an effective lockoff—all in one device. With a split back entrance fitting over the entrance duct.

Split, so that the cover may be bolted in place after the cable connections have been made—

Dome Shaped, to make room for an easy bend in the heavy incoming cables—

And designed for the use of an insulating compound to seal the service entrance against dampness, moisture, gases, seepage or flood water.

At the top—a straightaway fitting for the conduit leading to the meter board. A real installation wherever protection is one-half on the job and permanence the other half.

This is the Split-Back Entrance illustrated above

A complete line of fittings is available for all sizes of boxes

COLT'S PATENT FIRE ARMS MFG. CO.
ELECTRICAL DIVISION
HARTFORD, CONNECTICUT, U. S. A.
NEW YORK • BOSTON • PHILADELPHIA • CHICAGO • SAN FRANCISCO

B-W-21

On the job every hour

The need for uninterrupted service -- regardless of the date or hour — is well understood by Standard. So, you will find that all Standard wires and cables are built to assure minimum interruption.

Our representatives have an interesting story for you. Trained in practical problems, they have contributed much to Standard's ability to supply all types of wires and cables for the most exacting job. And they are fully capable of interpreting *our* service to *you*.

Engineers, research technicians, personnel, laboratories, wide manufacturing facilities — together they constitute a source of consultation, experiment, or supply which is worthy of your complete knowledge.

When may we tell this story? Will you name a date convenient for you?

STANDARD UNDERGROUND CABLE COMPANY
Division of General Cable Corporation
Perth Amboy, N. J.

STANDARD
UNDERGROUND
CABLE COMPANY

M-S-A *Waterproof* First Aid Kits

For Use on Trucks by Repair and Construction Crews

Duquesne Light Company, Pittsburgh, Pa.
Using M-S-A Waterproof Kit

M-S-A Waterproof First Aid Kits are built of 20-gauge steel to withstand rough usage. The contents, known as "Type D" Dressings, are put up in Unit Packages of Standard Size or Multiples of the Standard Size. The Unit Package arrangement permits interchangeability of contents to suit the requirements of the customer. These kits are available in 12, 16, 24 and 36 Unit Sizes. Ask for bulletin No. 36.

The 24-Unit Waterproof Kit with Inner Container Withdrawn and Opened

Safety First Pays!

Guard against infections and accidents in general . . . and thereby reduce insurance premiums. We would be glad to outline a plan for furnishing your entire safety requirements, including First Aid Materials, Gas Masks, H-H Inhalators, etc.

Write for Complete Information

Mine Safety Appliances Co.

Braddock, Thomas and Meade, Pittsburgh, Pa.

"Everything for Mine and Industrial Safety"

Cant hook

Careful Design

seen in each tool

Special features thruout our line, due to long experience in construction tool requirements, together with finest quality material, are a few of the reasons why these tools are in such great demand today.

Quick Shipments.
Ask for Catalog.

LEACH COMPANY
OSHKOSH WISCONSIN

OSHKOSH
POLE LINE CONSTRUCTION TOOLS

Carrying hook

MEMCO

Insulator Clamps
Copper Fittings
Splicing Sleeves
Disconnects
Choke Coils
Fuse Mountings
Substation Combinations
Air Break Switches
Bus Supports

Memco Engineering & Manufacturing Company, Inc.
381 Hamilton Street, Long Island City, N. Y.

Memco builds this equipment in all standard and special sizes—ask for bulletins of interest to you.

BELL

NORTHERN **CEDAR POLES** WESTERN

BUTT TREATING ANY KIND REQUIRED

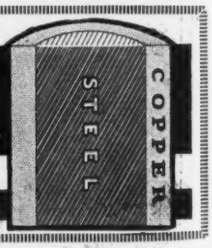
BELL LUMBER & POLE CO., *Minneapolis, Minn.*

"COPPERWELD"

Made by the Molten Welding Process

RUST PROOF BECAUSE PURE COPPER IS MOLTEN WELDED TO THE STEEL CORE

COPPERWELD STEEL CO., GLASSPORT, PENNA.



"Wonder" Cold Pipe, Tubing and Bar Benders

Standard of the World

HAND AND MOTOR OPERATED

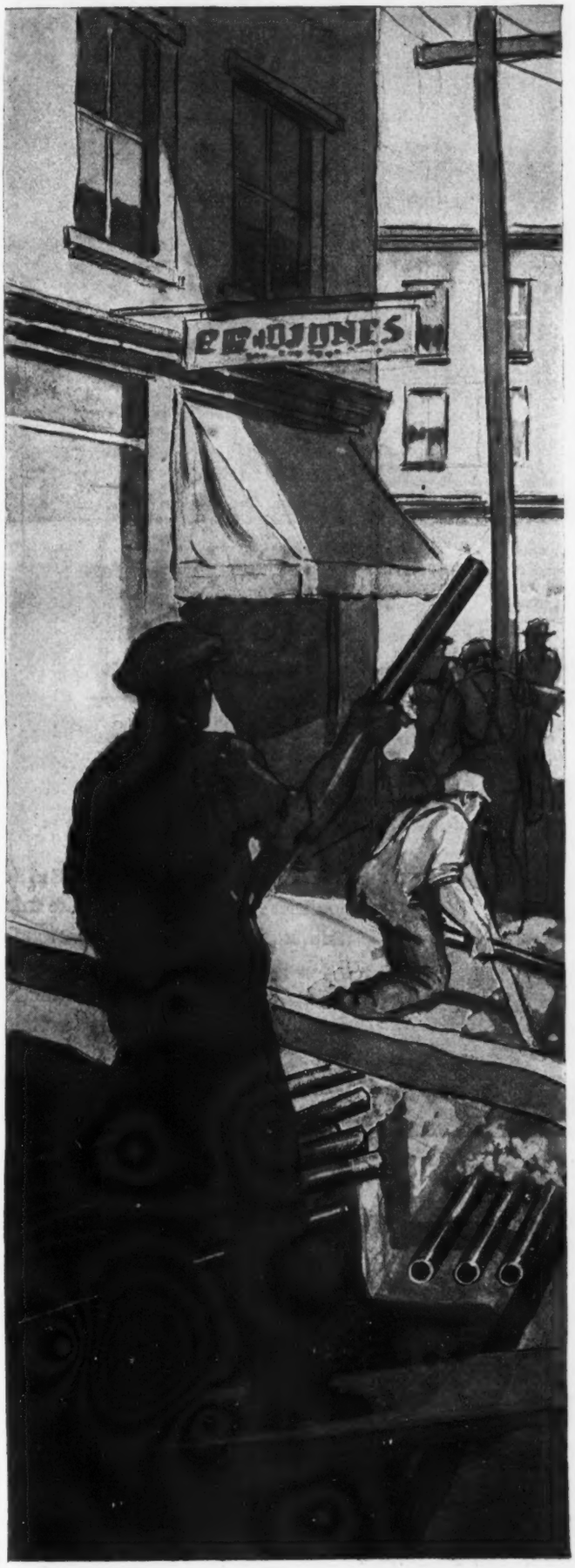
14 Sizes of Machines

What it costs to bend pipe our way. Per Bend:
1-in. pipe, 5 cents 4-in. pipe, 25 cents
2-in. pipe, 10 cents 6-in. pipe, 60 cents
3-in. pipe, $1.00

Send for Catalogue

American Pipe Bending Machine Co.
28 Pearl St., Boston, Mass. *One Year to Pay*

ORANGEBURG FIBRE CONDUIT



Easily handled in cramped quarters

THE uniform five foot lengths of Orangeburg Fibre Conduit make for easy handling when laying cableways through crowded streets. This uniformity of length is indicative of the care with which all Orangeburg Fibre Conduit is made. Being free from any interior roughness or irregularities, this conduit provides cableways which will never cause damage to cables which are being drawn into place.

The only real test of fibre conduit is actual service, actual performance in place.

The leading public utility companies and municipalities of the world have used Orangeburg Conduit for 36 years, thus establishing a history of success unapproached by any other conduit.

Wherever it is desired to install underground electric circuits for any purpose, Orangeburg Fibre Conduit can be counted upon as certain to provide the desired protection.

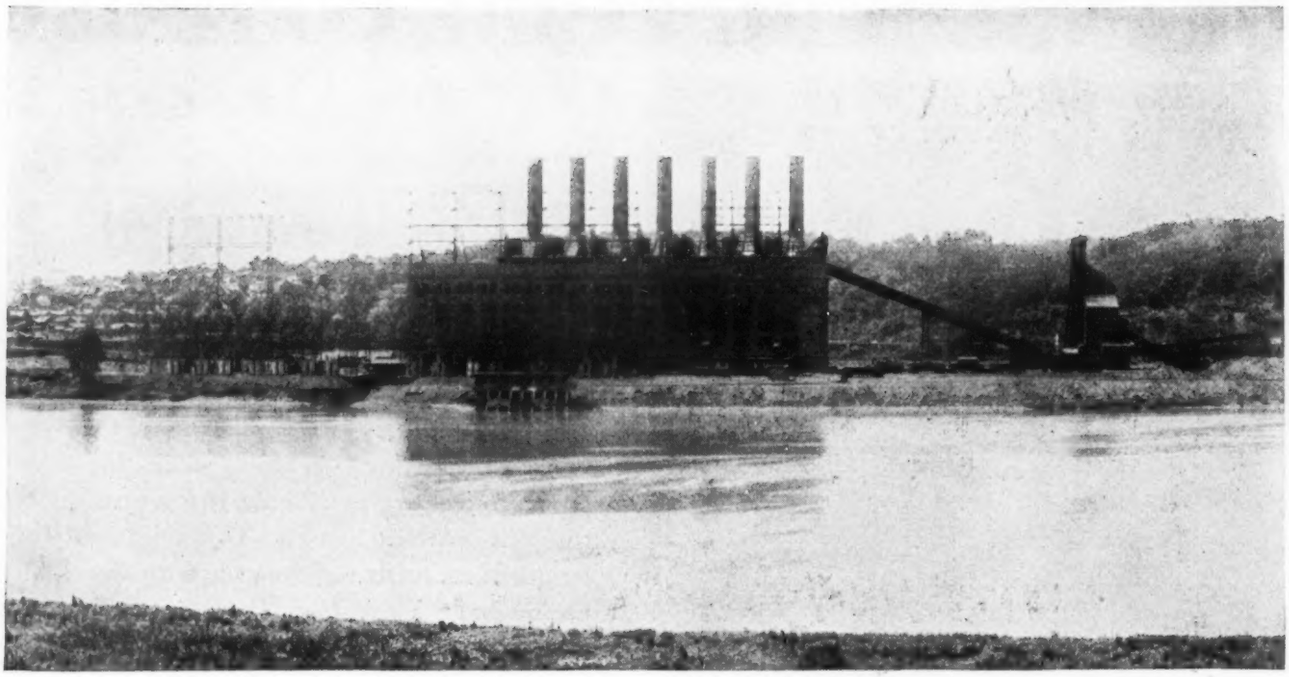
We are at all times prepared to furnish information, suggestions or estimates for the use of this safe, economical conduit. Address Johns-Manville Corporation, 292 Madison Avenue, New York.

THE FIBRE CONDUIT CO. REG. U.S. ORANGEBURG PAT. OFF. ORANGEBURG, N.Y.

The Fibre Conduit Co.
ORANGEBURG, NEW YORK

SOLE SELLING AGENTS

Johns-Manville
CORPORATION



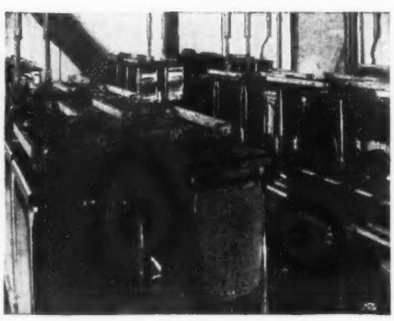
Springdale Station of the West Penn Power Company, 20 miles above Pittsburgh. This station is Exide-equipped for control bus service and emergency station lighting.

40 Exides help safeguard operation of West Penn Power Co.

Dependable Control Bus Operation is assured by these batteries

40 rugged Exide Control Bus Batteries — installed throughout the Company's system—handle oil circuit breaker operation and emergency station lighting efficiently and reliably.

At the Springdale Generating Plant, for instance (a plant with five steam turbine generators having a total capacity of 160,000 KV-A at 80% power factor), two 120-cell Exide Control Bus Batteries have been installed . . . selected for their reliability and long, active service.



View of part of 120-cell, 440 a. h. capacity Exide Control Bus Battery installed in Springdale Station of the West Penn Power Company. This station has another 120-cell Exide of 240 a. h. capacity.

These two outstanding Exide qualities—exceptional long life and unfailing dependability—have made Exide Control Bus Batteries the choice of power station engineers everywhere. They readily explain why practically every important power and light company in the country is today using Exides.

This booklet gives details

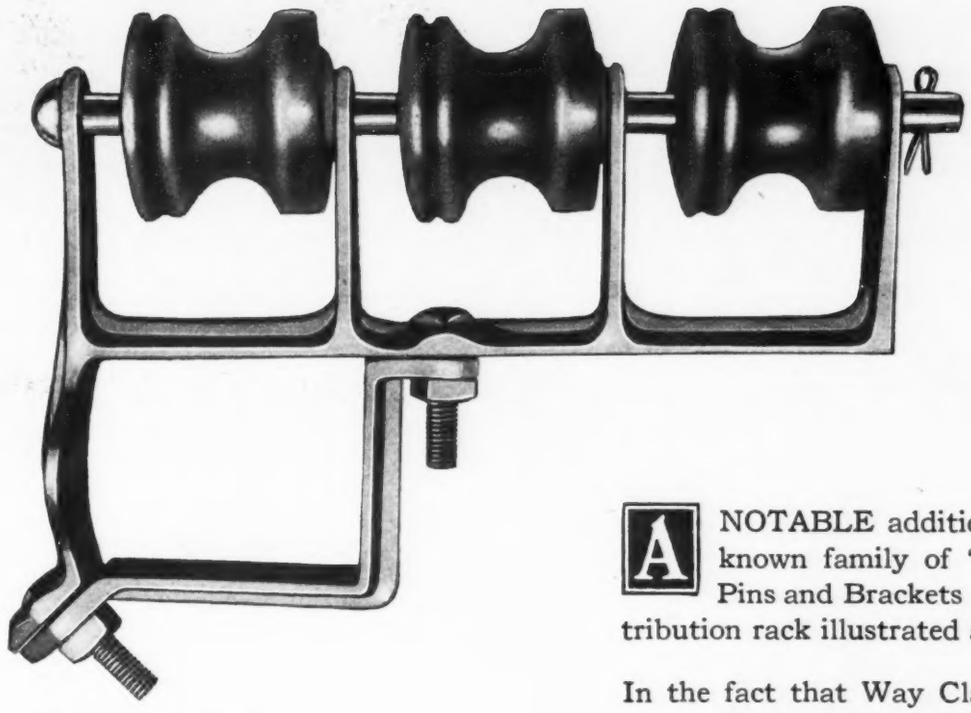
Exide Control Bus Batteries are the product of more than 41 years of battery-building experience. A booklet describing them and explaining their varied applications to the power station field may be had upon request. Write for Bulletin 202 today.

Exide
BATTERIES

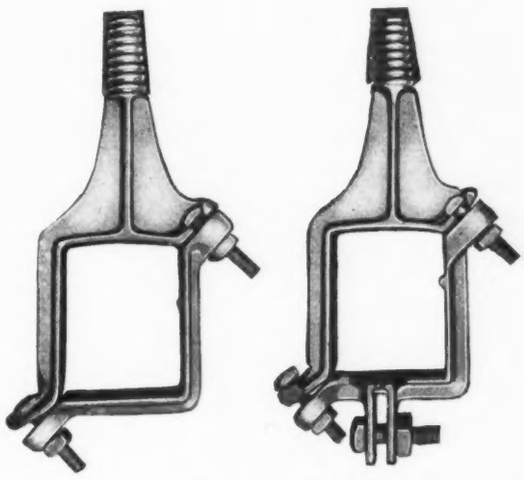
THE ELECTRIC STORAGE BATTERY COMPANY, Philadelphia

Exide Batteries of Canada, Limited, Toronto

Another "Way"



Way Distribution Rack
No. W31481—4
with Way Cross Arm Clamp
Made in all necessary combinations of spools, spacings, and cross arm sizes.



Way Clamp Pins
Malleable or Lead Thread Heads

A NOTABLE addition to the well-known family of "Way" Clamp Pins and Brackets is the new distribution rack illustrated above.

In the fact that Way Clamp Pins . . . made of St. Louis certified malleable iron . . . have been in use for over twenty years . . . there is a preponderance of evidence to bear out our contention . . . that these fixtures will outlast steel—stamped, forged or cast.

A feature of this rack is that when the clamp is applied . . . the clamp embraces and compresses the cross arm on all four sides . . . with no necessity of side bracing as is necessary where U bolts are used. The record of these racks in service demonstrates . . . they will increase the usable life of cross arms.

Write for our latest catalog . . . containing a complete line of malleable pole and line hardware.

ST. LOUIS MALLEABLE CASTING COMPANY

St. Louis, U. S. A.

AMERICAN STEEL & WIRE COMPANY
Electrical Wires and Cables

Engineers
J. E. Greiner Co.,
Baltimore, Md.
Electrical Contractor
Sam Donelson,
Atlanta, Ga.

On the World's Longest Highway Bridge

THE new James River Bridge, the longest highway bridge in the world, completely wired with American Steel & Wire Company Cables. Continuity of service on this wonderful project was of the utmost importance and so the very highest grade installation was made. Our Parkway Cables, 30 per-cent Rubber Insulated Lead Encased Copper Cables and several other constructions are performing the task of carrying the necessary current required for power and lighting.

Our cable engineers will gladly cooperate with you in connection with your cable problems. Write office nearest you.

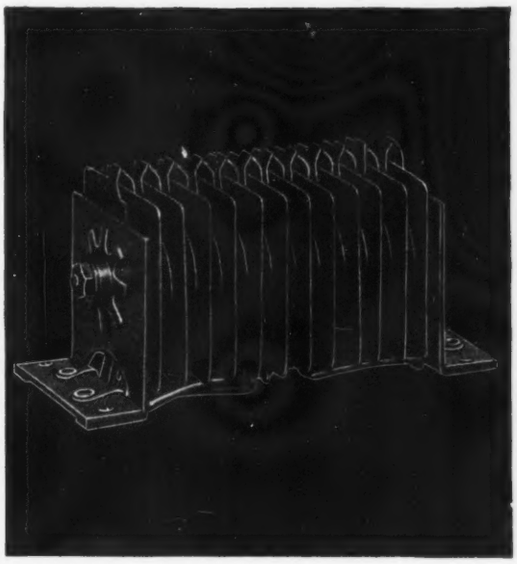
American Steel & Wire Company
Subsidiary of United States Steel Corporation

208 South La Salle Street, Chicago — 30 Church Street, New York

Other Sales Offices: Atlanta Baltimore Birmingham Boston Buffalo Cincinnati Cleveland Dallas Denver Detroit Kansas City Memphis Milwaukee Minneapolis-St. Paul Oklahoma City Philadelphia Pittsburgh Salt Lake City St. Louis Wilkes-Barre Worcester

U. S. Steel Products Co.: San Francisco Los Angeles Portland Seattle Honolulu

Export Distributors: United States Steel Products Co., 30 Church St., New York City



We have prepared a number of bulletins, each devoted to applications of Kuprox for specific purposes. Perhaps your very problem is covered in one of these bulletins. Write us and tell us briefly the type of application you are interested in. We will send you free the booklet treating on Kuprox applications in similar uses.

The Only Dry Rectifier *that does not depend upon pressure or chemical reaction*

Don't confuse Kuprox rectifiers with any other dry rectifier manufactured today. Kuprox is *electronic,* not electrolytic, in action. It is the only dry rectifier that does not depend upon pressure or chemical reaction. Thus it cannot deteriorate with age or service. Its action is constant, unvarying, dependable.

Kuprox Dry Copper Oxide Rectifiers can be adapted to any rectification need. They are in use in the operation of railway signals, telegraph and telephone systems, fire alarm equipment, time clock, signal and recording systems, traffic signals, electric hammers, dynamic speakers, medical apparatus and a host of other applications. They can be used wherever AC must be converted into DC, regardless of the apparatus or instrument to be operated.

Write and tell us your problems. Perhaps one of our standard installations would be adaptable. If not, a Kuprox rectifier can be built specifically to meet your purpose. Our engineers are anxious to work with you and will submit recommendations to suit your particular needs.

THE KODEL ELECTRIC & MFG. CO., CINCINNATI, OHIO

KUPROX

DRY COPPER OXIDE RECTIFIERS

Dependable SHERMAN Quality
for all
Soldering Lug Users

TERMINAL * HEADQUARTERS

Both the Heavy Duty and Standard types of Soldering Lugs designed and made by the H. B. Sherman Mfg. Co. were developed to fully and economically meet the needs of all users of Soldering Lugs. These Soldering Lugs can be depended upon for long service because of the material from which they are made and because of their design. You don't have to use cheaper lugs for economy now because Sherman Soldering Lugs are cheapest in the long run of service. The manufacturer who standardizes on Sherman Lugs protects his customers. Central Stations will find Sherman Lugs practical and economical. Look for Sherman Lugs on the equipment you buy.

Standard

They are marked with the N. E. C. rating in amperes across the flat portion at the wire end. They are made of seamless copper, of exactly correct gauge — better conductivity secured. Listed by Underwriters' Laboratories.

Heavy Duty

Made of seamless, extra heavy tubing exactly to dimensions prepared by an N.E.L.A. Committee. Flat contact surfaces. Free from burrs. Sturdy and dependable. Line complete and of adequate size and strength to meet all mechanical as well as electrical requirements.

TWO HOLE PAT. APP.

CENTER FORMED PAT. APP.

ANGLE PAT. APP.

Send for descriptive Bulletin on both types

H. B. SHERMAN MFG. CO.

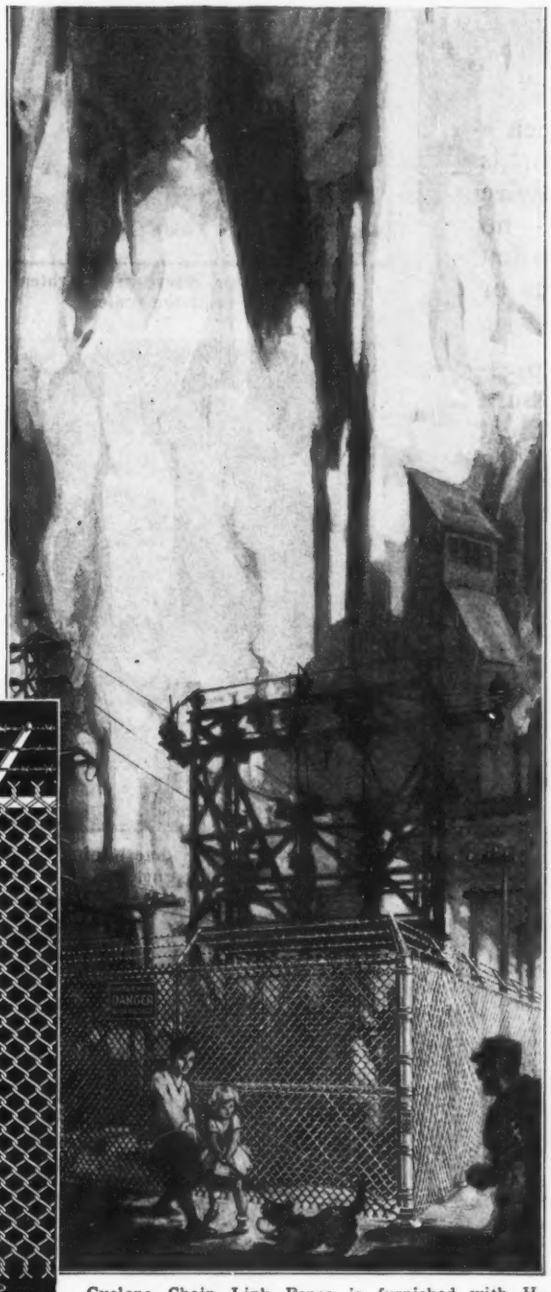
BATTLE CREEK, MICHIGAN

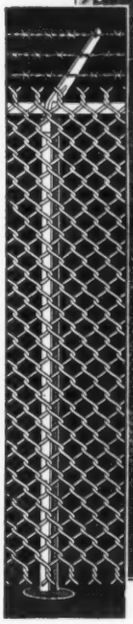
*Headquarters for Terminals

Sherman makes a high quality, complete, and economical line of terminals for the ends of the cables and wires. They are now generally accepted as the proper terminals to use because of their exclusive advantages and economy.

Ask for descriptive literature.

DO DANGER SIGNS PROTECT?





Cyclone Chain Link Fence is furnished with H-Column Posts—proved by tests the strongest fence posts made. Set in reinforced concrete foundations which resist cracking from frost action.

All chain link fence is not Cyclone. This name plate identifies the genuine Cyclone Fence.

Sometimes—but not always, because most of us are "Doubting Thomases." Whether it is a "Wet Paint" or a "Danger" sign we require at least a touch of the finger for proof—and with electrical property one touch may be fatal.

That's why electrical property requires the most practical protection known—Cyclone Fence. This sturdy, copper-steel fence provides positive two-way protection—on the outside it bars the curious public from dangerous ma-machinery and equipment; on the inside it protects the company's property from ma-rauders. Made of the most durable, weather-resisting materials, Cyclone Fence lasts for years—and because of its long life, it provides protection at low cost per year.

Cyclone Fence is made in a variety of styles for central stations, sub-stations and trans-former stations, also for industrial property of all kinds, schools, parks, airports, estates, etc. We also make sectional partitions and window guards. Cyclone Service is available every-where. We take complete responsibility for all installations. Write for details.

Cyclone Fence
REG. U.S. PAT. OFF.

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CYCLONE FENCE COMPANY
General Offices: WAUKEGAN, ILL.
Branch Offices in All Principal Cities
Pacific Coast Division: Standard Fence Company, Oakland, Calif.
SUBSIDIARY OF
UNITED STATES STEEL CORPORATION

Quality Products — *Dependable Service*

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AMERICAN SHEET AND TIN PLATE COMPANY
AMERICAN STEEL AND WIRE COMPANY
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DETERMINE TENSION

—accurately and quickly—

By the "Shunt" Method

It's not necessary to dead-end or cut the wires when a Martin-Loomis "Shunt Type" Tension Indicator is used. The indicator is merely clamped to the wire *before, during* or *after* tension has been applied—no cutting wires—no dead-ending. It indicates tension *accurately* up to a 16,500-lb. maximum on wires or cables up to ¾-in. diameter.

This exceptional device operates on a hydraulic pressure principle, the tension on the wire exerting pressure on a diaphragm supported by fluid. Readings—direct with special dial faces or with calibration curves (pressure readily converted)

Calibration tables for most sizes of wire and cable are furnished—special tables may be had if 40-inch sample of wire is sent.

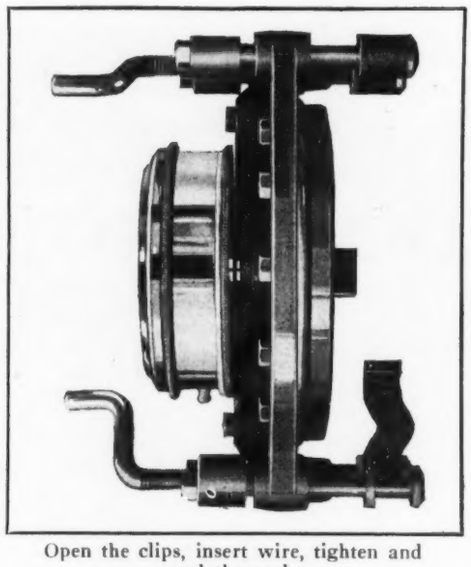
Only one instrument needed on a job.

The
TENSION
INDICATOR

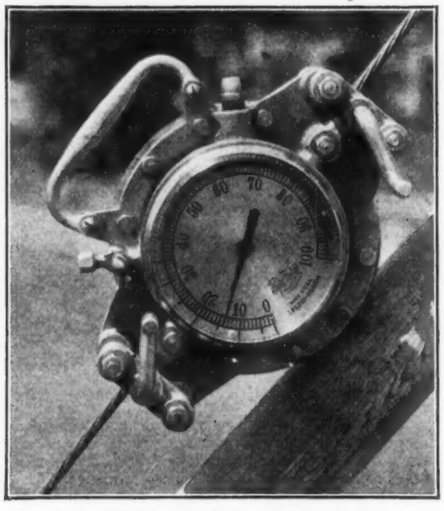
may be used to:

- "Sag-in" transmission and distribution lines.
- Adjust load proportionately on two or more guys on the same pole.
- Determine guy line strains on anchors.
- Determine types of tower footings best suited to various soils.
- These are only a few of its many uses.
- Write for literature and further information.

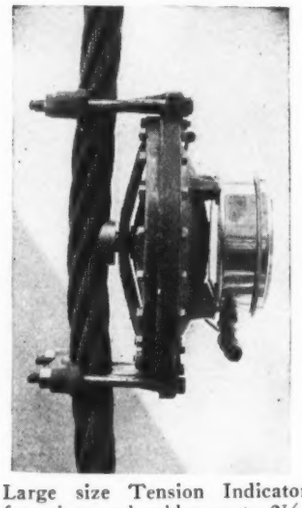
A larger instrument for lines up to 2¼-in. diameter and 260,000 lb. load is also available. A recorder, of strip or circular chart type, can also be supplied with the large Tension Indicator.



Open the clips, insert wire, tighten and read the scale.



The Indicator determining strain on a guy line.



Large size Tension Indicator for wires and cables up to 2¼-in. diameter and loads up to 260,000 lb.

MARTIN-LOOMIS CORPORATION

2827 Cherry Avenue, Long Beach, California

TO SECURE the most positive protection against decay and white ants the *entire* pole should be *pressure treated* with ZMA. ZMA is a treatment that assures permanent protection and affects neither the strength nor the natural color of the wood. It is especially effective in protecting poles against termites.

Distributed by

PENDLETON-GILKEY COMPANY

Office: McKnight Bldg., Minneapolis, Minn.

Plant: Spokane, Washington

For further information communicate with:

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TIMBER PRESERVATION ENGINEERS

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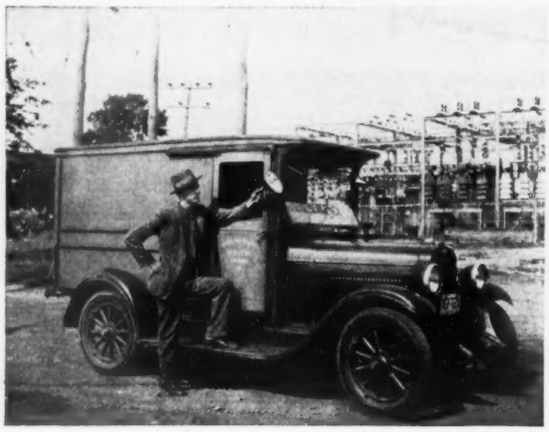
Finance Building, Philadelphia — *Wrigley Building, Chicago, Ill.* — *New Orleans Bank Building, New Orleans, La.*

Electric Power Bldg., Chattanooga, Tenn.

CURTIN-HOWE CORPORATION, Ltd.

McGill Building, Montreal, Canada

ZMA 29



Half-Mile-Ray Electric Searchlight on Emergency truck of Narragansett Electric Light Co., Providence, R. I.

Five Years in Service

The first two "Half-Mile-Rays" purchased by the Narragansett Electric Light Co. were recently replaced, after five years of riding over rough roads and exposure to all kinds of weather. Repeat orders from Narragansett, and from hundreds of other utility companies, speak louder than words as to the practical value of the

Half-Mile-Ray
Electric Searchlight

Style No. 100 for Cars and Trucks

Its powerful beam quickly locates trouble along the line at night, and floods the cross-bar structure with light while repairs are being made. Every trouble crew needs this light for greater safety as well as for greater speed in finding and repairing trouble at night.

Standard equipment with more than a thousand Public Utilities—you can get in line by filling out and sending in the coupon below.

Style No. 600 Portable Storage Battery Outfit

THE PORTABLE LIGHT CO., Inc.
14 Warren Street, New York City.

Please send me prices and additional information about "Half-Mile-Ray" Electric Searchlights.

Name ..... Company .....

Address .....

WE EXTEND the facilities of our organization to those desiring information or reports on companies with which we are identified.

Electric Bond and Share Company

Two Rector Street New York

HEMINGRAY

made in sizes up to* 15,000 *volts

EST. 1848

INC. 1870

For medium voltage lines
Insulate with Glass

Advantages!

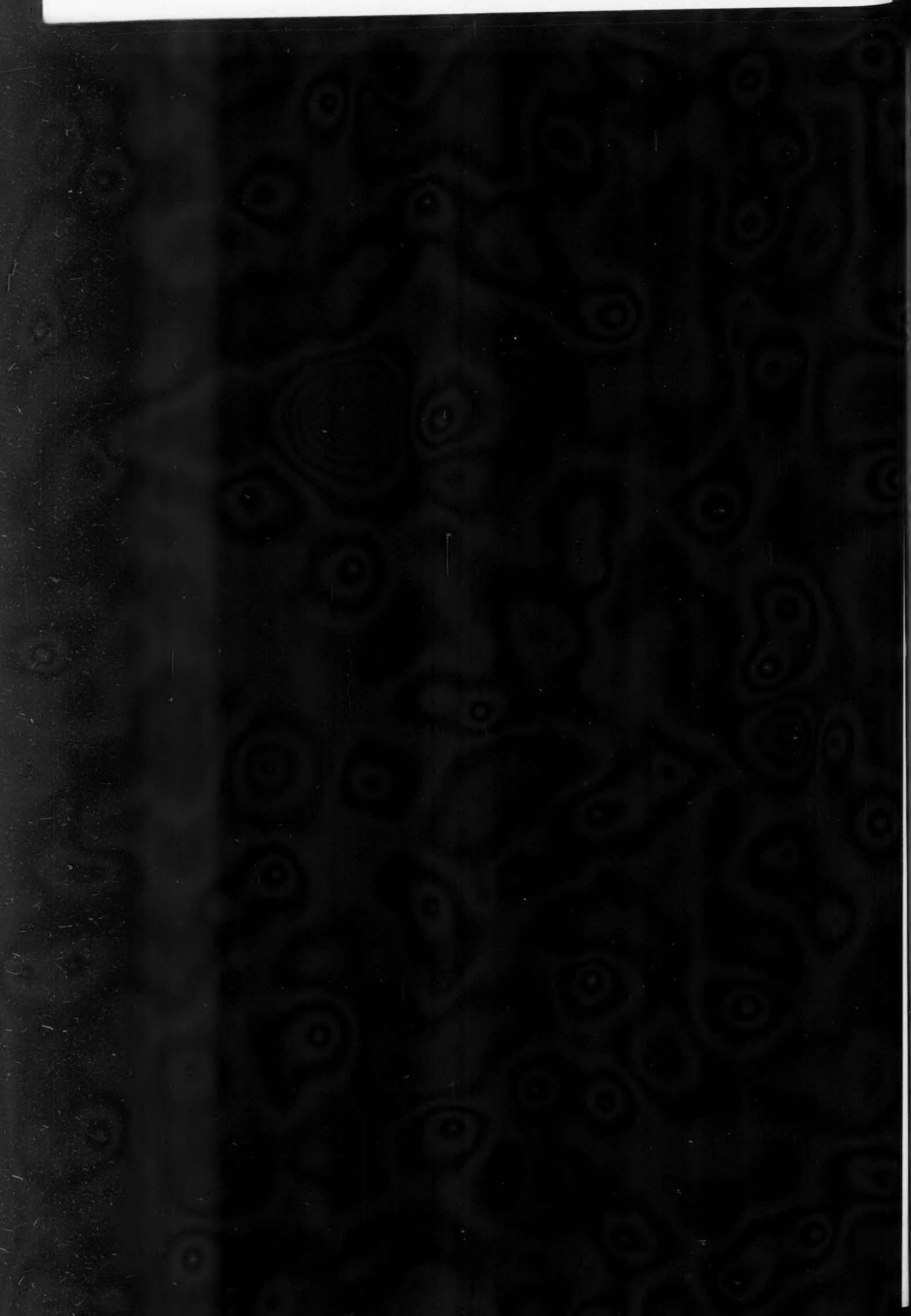
(1) Transparency
Exposes internal defects

(2) Non-Porosity
Eliminates Moisture Absorption
Sustains dielectric strength
Prevents deterioration

(3) Homogenity
Insures uniform insulating properties throughout each insulator.

Up to 15,000 standardize on Glass

HEMINGRAY GLASS CO.
General Office and Factory Muncie, Ind.



E (EQUIPMENT) + **P** (PROTECTION) = **M** (MAINTENANCE)

COST OF ANCHOR?

HOURS OF UNCALLED FOR EXTRA LABOR IN MAINTENANCE.

ACCOUNTING CHARGES LISTING INCREASED PRODUCTION COSTS!

NEVER ECONOMICAL.

CAN BE AVOIDED!

ENTIRELY IN THE ADOPTION OF A CHANCE NEVER-CREEP, EXPANDING, CONE OR SCREW ANCHOR, WHEN SELECTED FOR LOCAL GROUND CONDITIONS

Chance Company

CENTRALIA, MISSOURI.

Manufacturers Of

Never-Creep Anchors — *Cone Anchors*

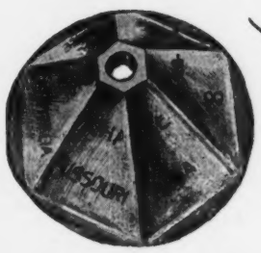
Expanding Anchors — *Screw Anchors*

Thimbleye Anchor Rods

Thimbleye Bolts - Straight & Angled

Chance Capstan Pulley Blocks

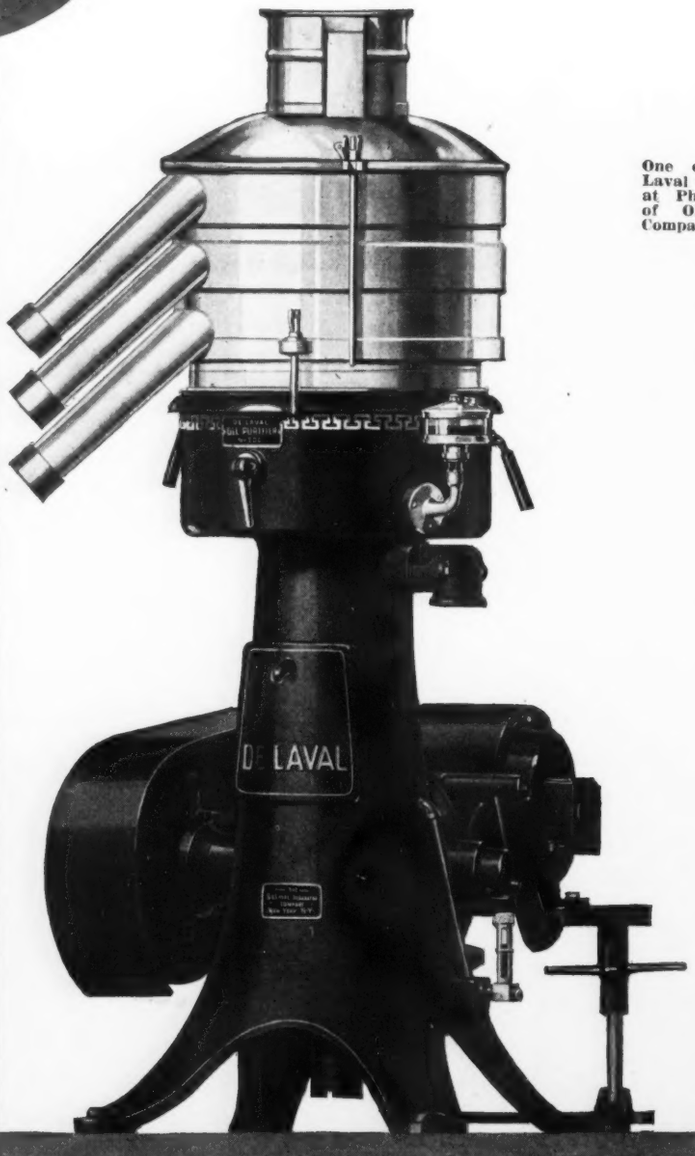
& A Full Line Of Guying Specialties



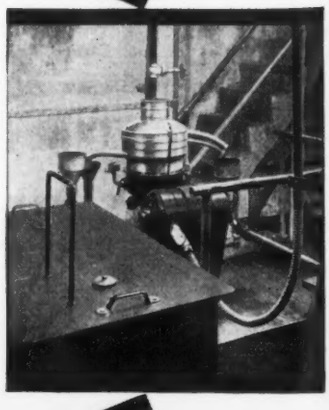
Distributed By

LEADING WHOLESALERS OF ELECTRICAL MATERIALS.

75% of the most m DE LAVAL C



One of the De Laval Oil Purifiers at Philo Station of Ohio Power Company.



A De Laval at Columbia Station of Columbia Gas & Electric Company.

A battery of De Lavals at Hudson Avenue Station of Brooklyn Edison Company.

modern steam plants use OIL PURIFIERS

THE growing use of De Laval Oil Purifiers by leading American electric power systems is indicated by the fact that 91% of those reporting a yearly output in excess of one-half billion kw.-hr. for 1928 are users of these machines. In 1924, when the number of the systems in this class was considerably lower, only 80% were De Laval users.

In this group of great power companies are 26 systems having outputs of more than one billion kw.-hr. yearly. Every one of these greatest companies uses De Laval Oil Purifiers.

The De Laval Company is extremely proud of the enviable position which its machines have attained in the central station industry, and has recently further checked up its progress in this field as follows:—

A recent issue of Electrical World contained a list of 41 outstanding steam plants built since 1924. These are what might be termed the ultra-modern stations in the field.

Of these 41 stations, 31, or almost exactly 75%, have already been equipped with De Laval Oil Purifiers, the number of machines installed in an individual station ranging from one to eight.

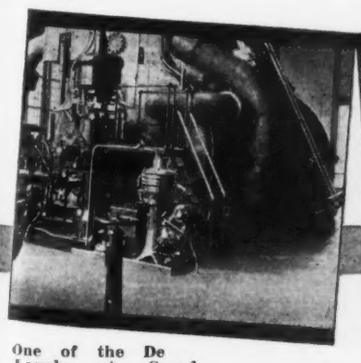
In a few of the stations listed no oil purifying apparatus has yet been specified so that De Laval's final percentage will in all probability be somewhat increased.

The fact that several of the new stations in the Electrical World list have been built by companies which do not appear on the list of "leading systems" indicates that De Laval's lead in *new* stations throughout the entire industry is even greater than in old ones.

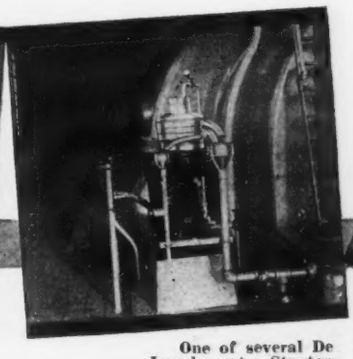
Bulletin No. 106-W on lubricating oil or No. 107-W on insulating oil will help explain why the name "De Laval" has become synonymous with "Oil Purifier." Write for a copy today.

THE DE LAVAL SEPARATOR COMPANY
165 Broadway, New York **600 Jackson Blvd., Chicago**

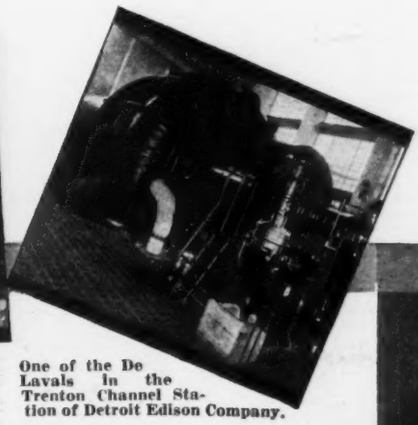
DE LAVAL PACIFIC COMPANY 61 Beale St., San Francisco
THE DE LAVAL COMPANY, Ltd. Peterborough and Winnipeg, Canada
ALFA-LAVAL CO. Ltd. 34 Grosvenor Road, London, S. W. 1.



One of the De Lavals at Grand Tower Station of Central Illinois Public Service.



One of several De Lavals at Stanton Station of American Gas & Electric Company.



One of the De Lavals in the Trenton Channel Station of Detroit Edison Company.

Use it Free for 10 Days

Croft's
American Electrician's Handbook

By TERRELL CROFT
823 pages, flexible, pocket size. 900 illustrations. $4.00 net, postpaid

A valuable investment for every man in electrical work

This great handbook of practical electricity is the recognized book for the electrician. It will help you save time both "on the job" and in the shop.

3,000 Electrical Problems are explained in this compact handbook. It helps solve those electrical problems which confront you in your daily work.

This is the one standard electrical help containing all the data, kinks, short-cuts, helps and other information that the practical electrician, wireman, lineman, contractor, plant superintendent and construction engineer needs.

The book is brimful of those facts which every man engaged in electrical work needs to know.

Think how much help you would be able to get from a convenient pocket-size handbook that gives you in one book—

Practical suggestions for locating and correcting both motor and generator troubles—
Clear directions for proper installation and operation of motors and generators—
Explanations of fundamentals of practical electricity—
Helpful data on transformers—
All the details the practical man needs on wiring for light and power.
All these topics and many more are covered in this revised second edition of **Croft's Handbook.**

Make this your biggest year—

Prepare now for advancement and bigger pay. This handbook will help you—have your own copy and keep it with you for quick reference on the job. It will help you gain promotion. Send for a copy for 10 days' free examination.

MC GRAW-HILL
FREE EXAMINATION COUPON

McGraw-Hill Book Company, Inc., 370 Seventh Avenue, New York
Send me Croft's American Electricians' Handbook, $4.00 net, postpaid, on 10 days' approval. I agree to pay for the book or return it postpaid within 10 days of receipt.
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Some One Wants To Buy

the equipment or machinery that you are not using. This may be occupying valuable space, collecting dust, rust and hard knocks in your shops and yards.

Sell it

before depreciation scraps it.

The Searchlight Section is helping others— Let it help you also

WALTER BATES STEEL CORPORATION

GARY INDIANA

Steel Poles

from

FOUR EXPANDED ANGLES

Low Cost—Substantial

Towers
Sub-Stations
Poles

Steel Grating

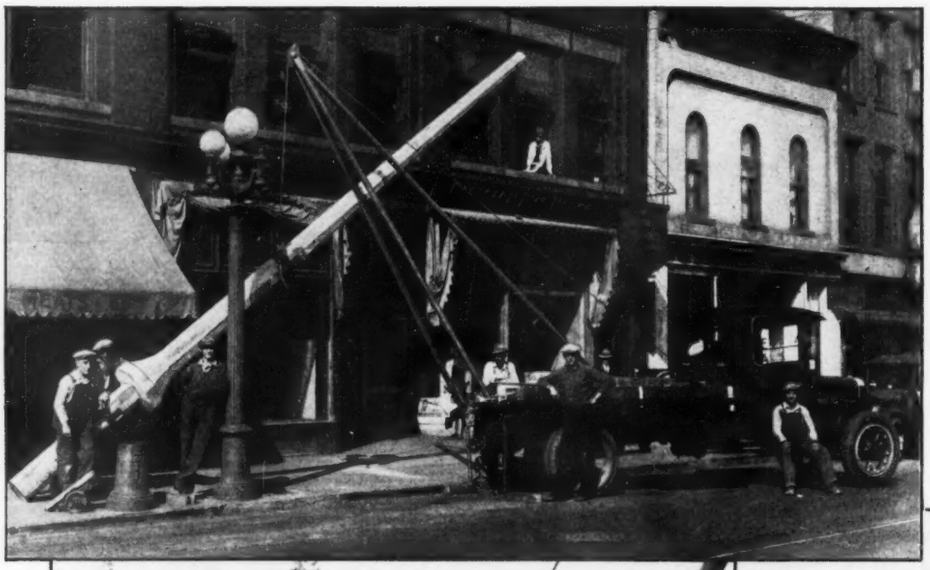
Copper Bearing Steel

Quadrangular Mesh

"Copperquad"

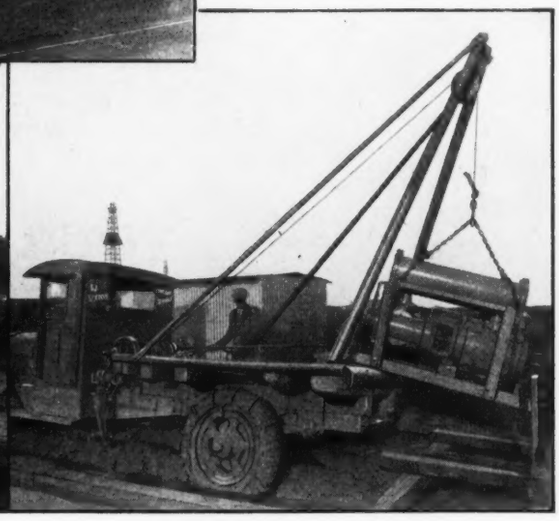
MEAD-MORRISON WINCH EQUIPMENT

A Complete Line of Winches, Cranes and Derricks for every Public Service Requirement

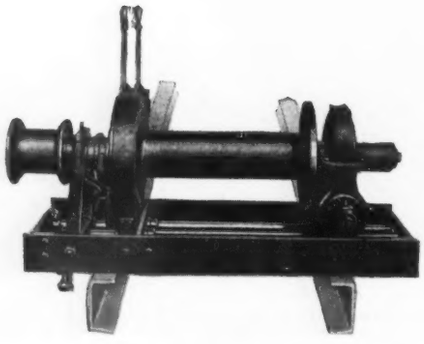


The Lighting Department, City of Grand Rapids, Mich., used the No. 915 Winch with the Mead-Morrison Pole Derrick to set the new 4200-pound concrete boulevard poles in Division Avenue of Grand Rapids. "This equipment saved one-half the cost and used one-half the number of men as compared with the previous methods."

(Left): The Mead-Morrison No. 915 takes but little room on the deck of your truck. Levers are placed inside the cab, protecting the operator from the weather.



Above: No. 915 Hauling Pumps



A Close Up of Winch 915 Shown Above

Our engineering service and experience assures you of: 1. the right winch for your work; 2. the proper driving parts; 3. correct installation.

If you wish to see what others are doing, just drop us a line on your company letterhead, asking for our Catalog 31, which contains many installation photographs of our several models of Winches pulling cable, of our Pole Derricks setting poles, and of our Cranes especially arranged for handling transformers.

MEAD-MORRISON MFG. CO.
526 Prescott St., Boston, Mass.

Sold and Serviced by 40 Distributors Located in the Principal Centers Throughout the U. S.

ELECTRICAL AND MECHANICAL PERFECTION!

240 Volt 320 A.H., 9 FPG Philco Control Battery in Steel Glass. Holland Generating Station, Holland, N. J. Metropolitan Edison Co., Reading, Pa.

Philco Processed Plates

WHAT? THE KEYSTONE OF ELECTRICAL PERFECTION AND LONG LIFE! Philco's patented process produces plates of more uniform Hardness, Porosity and High Capacity. Twenty-three years of Philco specialization have perfected this advanced method of plate manufacture. ***Field performance has emphasized perfection.***

HOW? The Diamond Grid (plate frame) is filled with a blend of specially prepared lead oxides and acid, ***then*** dehydrated (dried quickly) in a chamber of superheated steam under 675 lbs. pressure. ***Thermostatic control of temperature and close technical control of the entire process insures absolute uniformity.***

WHY? SEPARATE OPINIONS FROM FACTS! Space today is at a premium. Modern conditions demand Reliable, Long-life, High-capacity, Spray-proof Power Batteries ***Mechanically Strong*** at Reasonable Cost.

PHILCO LEADS IN DEVELOPMENT TO MEET MODERN DEMAND

WATCH THE 11 SUPERIORITY POINTS, M-O-N-T-H - B-Y - M-O-N-T-H

PHILCO
DIAMOND GRID BATTERIES

THE 11 POINTS TO PHILCO . . .

1. STEEL-GLASS
2. Corner and Side Locks.
3. Diamond Grids.
4. Philco Processed Plates.
5. Philco Slotted Retainers.
6. Quarter-Sawed Hardwood Separators
7. Spray-Proof Funnel Vents.
8. Built-in Charge Indicators and Thermometer.
9. Burned-Bolted Connectors.
10. Shipped Fully Charged.
11. Lowest Space Installation and Maintenance Cost.

Philadelphia Storage Battery Company. ***Power Division:***
Ontario and C Streets, Philadelphia, Pa.
Please send me Bulletin No. 956 describing in complete detail Philco Spray-Proof Power Batteries in Steel-Glass.

Name .....

Street .....

City ..... *State* .....

TUNE IN ON THE "PHILCO HOUR"

LIGHT'S GOLDEN JUBILEE

Federal Applique Lighting Units For Effective Celebration

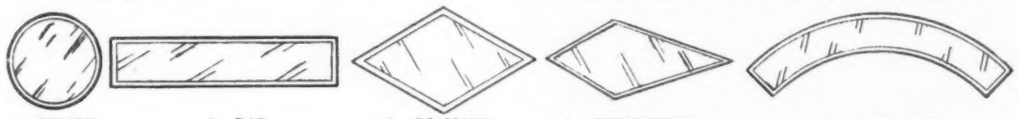
In anticipation of the demand for decorative lighting units for buildings, to be used in celebration of Light's Golden Jubilee, the lighting units shown and described below have been made available.

Simple and durable in construction, colorful and attention compelling in appearance, these lighting units, used in various combinations to decorate the exterior of a building, will serve as forceful and attractive reminders of the building which they light, will lend themselves admirably to the festival of light—Light's Golden Jubilee.

With interior illumination, the face of the units are of glass which may be had in any of the following six colors: White, Orange, Blue, Green, Red or Yellow.

With exposed lamp illumination the glass face of the unit is eliminated and S-11 colored lamps used instead. The exposed lamp units are used, of course, in the same manner as the Interiorly Illuminated Units.

In ordering, specify units by number (1, 2, 3, 4, or 5); specify whether glass faced or exposed lamp units are desired, and color wanted.



	1 CIRCLE	2. BAR	3. DIAMOND	4. SPEAR HEAD	5. QUADRANT
No.	1.	2.	3.	4.	5.
Size	6" dia.	12"x2½"	14"x8"	14"x6"	12½"x12½"
Glass Face	2 Sockets—$4.45 unit	3 Sockets—$1.85 unit	4 Sockets—$7.15 unit	3 Sockets—$5.90 unit	4 Sockets—$6.85 unit
Exposed Lamp	6 Sockets—$5.25 unit	6 Sockets—$5.25 unit	16 Sockets—$8.80 unit	14 Sockets—$8.80 unit	9 Sockets—$6.80 unit

FEDERAL ELECTRIC COMPANY
8700 South State Street Chicago, Illinois

Assembling form in excavation.

HOW TO SAVE TIME AND MONEY ON CONCRETE MANHOLE CONSTRUCTION

Use PENOTE SECTIONAL STEEL MANHOLE FORMS

(Patented)

Consider the expense of constructing concrete manhole forms by the old method of building individual forms, and figure out the cost of time and material, you will find it runs high. Many of the largest public utility companies are cutting this manhole construction-cost way down, by using Penote Sectional Steel Manhole Forms.

These forms are strong and sturdy, practically indestructible. They deliver constant efficient service over a long period of years, are easily installed in the excavation and removed from finished job. An ordinary hammer is the only tool required to assemble or dismantle. They save expensive labor and eliminate big lumber wastage; have great flexibility and adaptability and assure high efficiency under all soil conditions.

Penote Patented Forms have been in use for many years. Constructionally, they are precision built in accordance with exact specifications and with complete knowledge of all conditions that must be met in various types of manhole construction work.

The purchase price of Penote Patented Forms is small when you consider that they will easily pay for themselves in the construction of only a few concrete manholes.

Let us send descriptive data or quote on your requirements.

Common type of Electric Light Manhole Form—set up.

THE CLEVELAND TRENCHER COMPANY
20100 ST. CLAIR AVE., CLEVELAND, OHIO

There's the big saving with an Earth Drill

Whether it's the Tractor, Truck, or Trailer mounted type, it's the *speed of digging* on the job that cuts the cost per hole *more than half* whenever an Earth Drill is used.

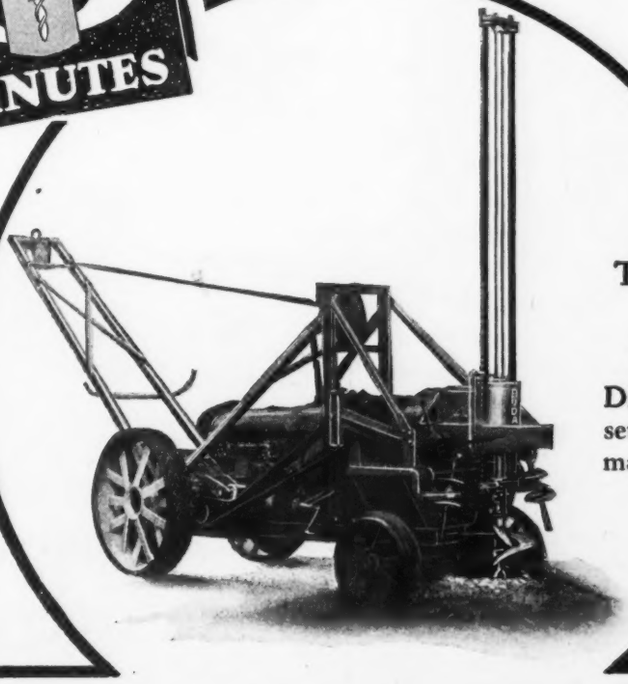
Its speed comes from the many features of design that our experience has proven to be advantageous.

Ample power is supplied by the special Buda Gasoline Engine. Ball bearing drive shafts and unusually rigid frame construction afford full power to the drill. Special non-clogging, roller chains, and enclosed gearing insures continuous operation.

Let us send you full details.

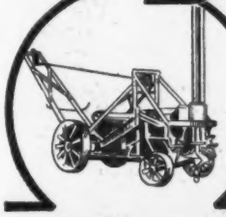
THE BUDA COMPANY
Established 1881
HARVEY Chicago Suburb ILLINOIS

Ask for Nielsen Certified Surveys of the Earth Drill in actual operation. State whether you are interested in Tractor ☐ Truck ☐ or Trailer ☐ Type.



TRACTOR MOUNTED EARTH DRILL
with pole setting derrick
Digs holes, loads, hauls and sets poles; strings lines on maintenance or construction.

BUDA-HUBRON EARTH DRILL



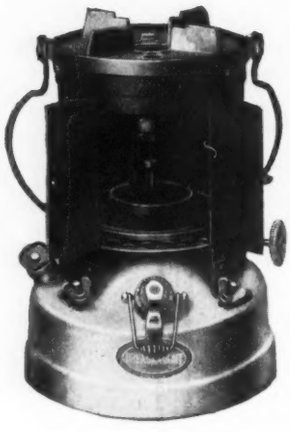
FOR TRACTOR·TRUCK OR TRAILER MOUNTING

have you seen
The BIG BRUTE

Can you do this with the furnace you are now using?

Service with Safety

- Larger tank
- Greater fuel capacity
- Wider, more stable base
- BRAZED BOTTOM and connections
- Easily accessible—top tilts back
- Acme of serviceability and long life

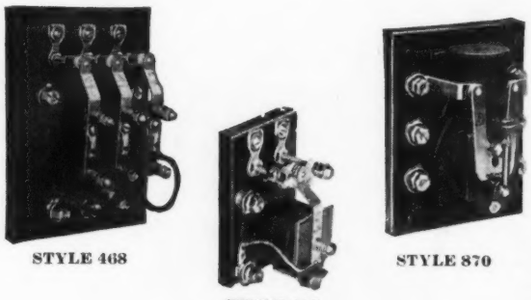


This newest WALL DREADNAUGHT Furnace—the BIG BRUTE—compels the attention of all maintenance men. For here is a special furnace built for a special job—and proven by months of use by many prominent public service companies under severest conditions. It is a bold departure from former types, yet is long past the experimental stage. It is designed to withstand the use and abuse of every-day splicing service with notable advantages not found in any other make or type.

P. WALL MFG. SUPPLY CO.
3126 Preble Ave. N.S., Pittsburgh, Pa.
[Since 1864]

WALL "BIG BRUTE" DREADNAUGHT
Splicers' Furnace

IMMERSION THERMOSTAT



STYLE 468 STYLE 405 STYLE 870

STYLE 410 STYLE 429 STYLE 437

STYLE 466

Choose from over 100 styles of

DUNCO relay switches

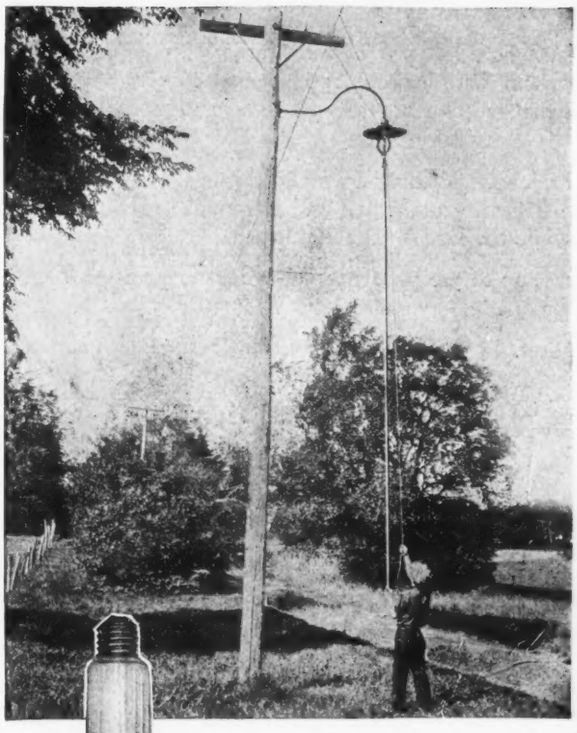
Dunco Relay Switches and thermostats are manufactured with individual attention and are designed and constructed for reliability and durability, silent operation and effective response to the service required.

May we assist in solving your control problems?

Our catalog R-2 gives styles and wiring diagrams. Send for your copy.

STRUTHERS DUNN, Inc.
1123 Race Street,
Philadelphia, Pa.

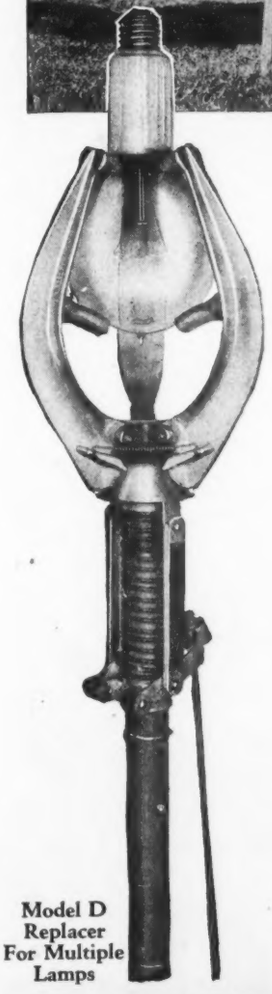
The G.C.A. Lamp Replacer



A modern tool that cuts down maintenance costs

It isn't difficult to conceive the enormous amount of time your own maintenance men could save by replacing series and multiple lamps and lamp bases with the aid of the G.C.A. Lamp Replacer.

No ladders to tote and climb. No need for climbing irons. The old lamp can be removed and replaced with a new one, right from the ground.



Model D Replacer For Multiple Lamps

The G.C.A. Lamp Replacer is a simple clutch mechanism mounted on the end of a sectional pole. Made in two types—one that pulls the socket with the old lamp and replaces the socket with a new lamp in it—and another that unscrews the old lamp and screws in the new. Each type is made in all models required to handle standard lamps and fixtures. Special models are available or can be designed for your special fixtures.

The G.C.A. Fuse Plug Puller will remove and replace all types of primary cut out and pole line fuse plugs, both of the straight pull down and the quarter twist types. It may be attached to the same sectional handle that is used with the G.C.A. Lamp Replacer. No need for the line man to carry two handles.

G.C.A. Replacers, Fuse Plug Pullers and Lamp Base Removers are inexpensive to buy. Their use will make pole climbing and its consequent risks unnecessary. Safer for the men—and will enable them to do more work with less effort.

G.C.A. Equipment pays for itself so quickly that no public utility can afford to be without it.

Write for catalog.

Model FP-1 Fuse Plug Puller

The G.C.A Manufacturing Co., Pittsfield, Mass.

Are You Penalized

by Bad Power-Factor?

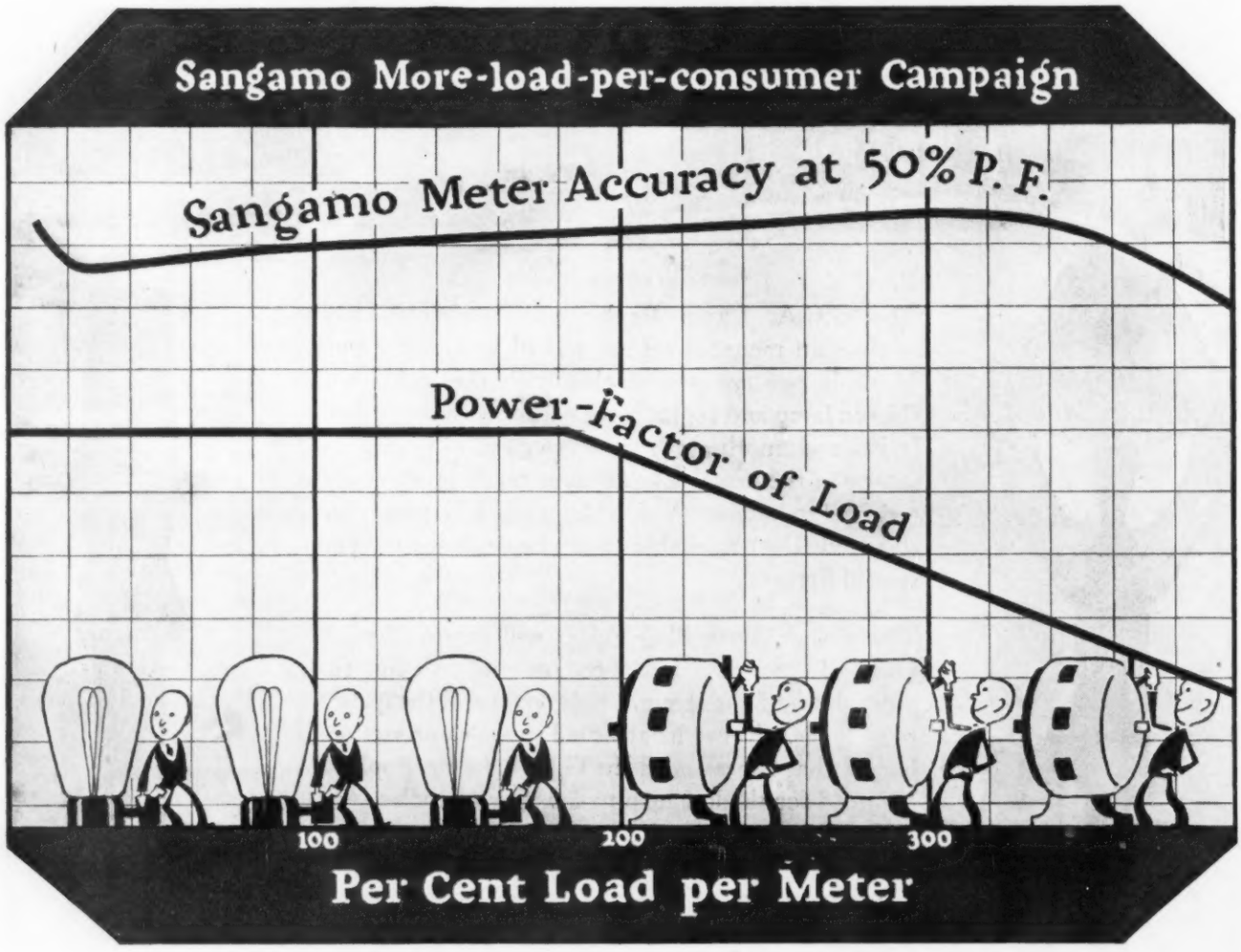
With more and more low power-factor motors coming into the home, the question of power-factor assumes more and more importance in domestic metering. The trend is all toward more power in the home and that means more load per meter and more load variation per meter.

Even at low power-factor, Sangamo HC Meters maintain their accuracy over a wide load range. They are designed for modern conditions. They bridge the gap between one meter and the next larger capacity without loss of income due to reduced accuracy while the load is building up.

The HC Meter has a straight-line accuracy from the lightest up to 300 per cent load and is temperature compensated from 20 deg. to 120 deg. F. at all power-factors.

Supplement 67 tells all about the HC Meter. Sent on request.

All modern American meters are far superior in their performance on overload and varying temperature to the best made five years ago. This high degree of perfection in manufacture is due largely to the full cooperation between the American meter manufacturers and the two great national meter committees.



SANGAMO

ELECTRIC COMPANY ▾ ▾ ▾ SPRINGFIELD, ILLINOIS 8331-6

ELECTRIC WELDING

REQUIRES AN EFFICIENT TRANSFORMER

In choosing the transformer for your welding machine, three factors are of utmost importance:

1. Flexibility—(to suit any circuit).
2. Reliability—(24 hour service, without interruption, if necessary).
3. Economy—(long life with a minimum of repairs).

The American Transformer Company has consistently endeavored to uphold these standards of efficiency. In the welding industry they have closely followed each new development. The result is a staff of engineers competent to advise you on your electric welding problem regardless of its unusualities. Their advice entails no obligation, of course.

AMERICAN TRANSFORMER COMPANY
178 Emmet St., Newark, N. J.

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W. O. Taylor & Co., Ltd.
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Elliott Equipment Co.
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San Francisco, Calif.
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682 Mission Street

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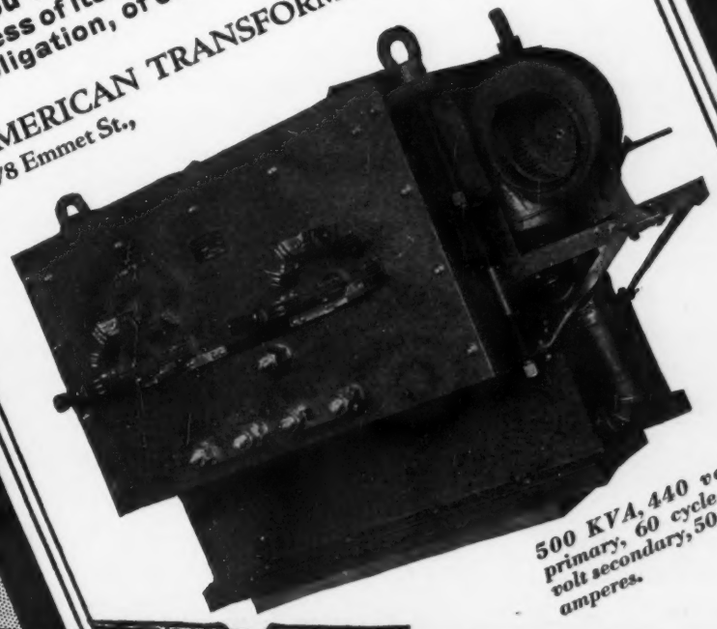


500 KVA, 440 volt primary, 60 cycle 10 volt secondary, 50,000 amperes.

AMERICAN TRANSFORMER

STATES Products

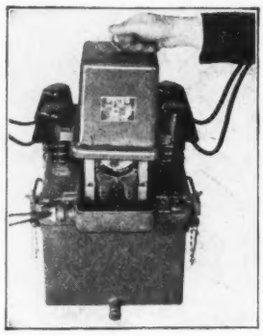
Time Switches

Widely Known as "The World's Finest"

100 Amp. Cap.

Supplied in a wide variety of capacities

High and low tension



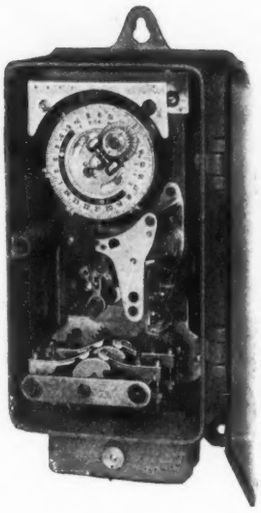
A few of many uses:

Lighting Circuits— highways, parks, signs

"Off-Peak" Circuits

Traffic Signals and Airport Lights

Automatic Sub-stations



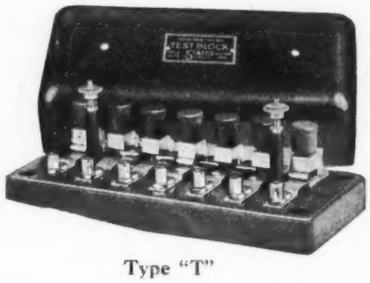
Dependable—Accurate—Self-Winding—Automatic

Test Blocks

States Meter Test Blocks simplify the installation, changing and testing of watt hour meters. With these test blocks in place the meter is protected as well as the person making the test. Meters require care and caution in handling not only that the accuracy of the transformers be unimpaired but that the person making or changing the connections may be safe from injury through accidental opening of the secondary of a current transformer.

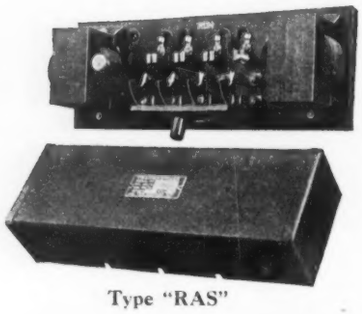
Type "SJ"

These test blocks are especially recommended for use on all power services and also in industrial plants where AC current is metered to departments.



Type "T"

A States Meter Test Block is good insurance.



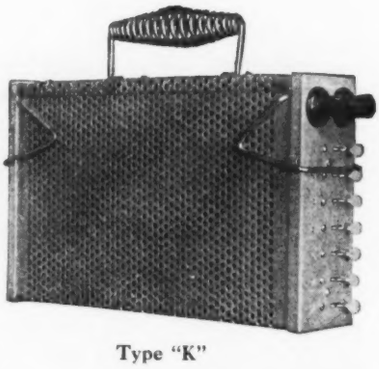
Type "RAS"

Quadraphaser
(phasing transformer)
adapted for both KVA. and reactive component metering

See Cat. No. 1, Sec. 10

Resistance Load
to meet the need for a rugged, lightweight, non-inductive load

See Cat. No. 1, Sec. 5



Type "K"

Systematic meter testing
THE STATES COMPANY
Pays Handsomely

43 New Park Ave. Hartford, Conn.

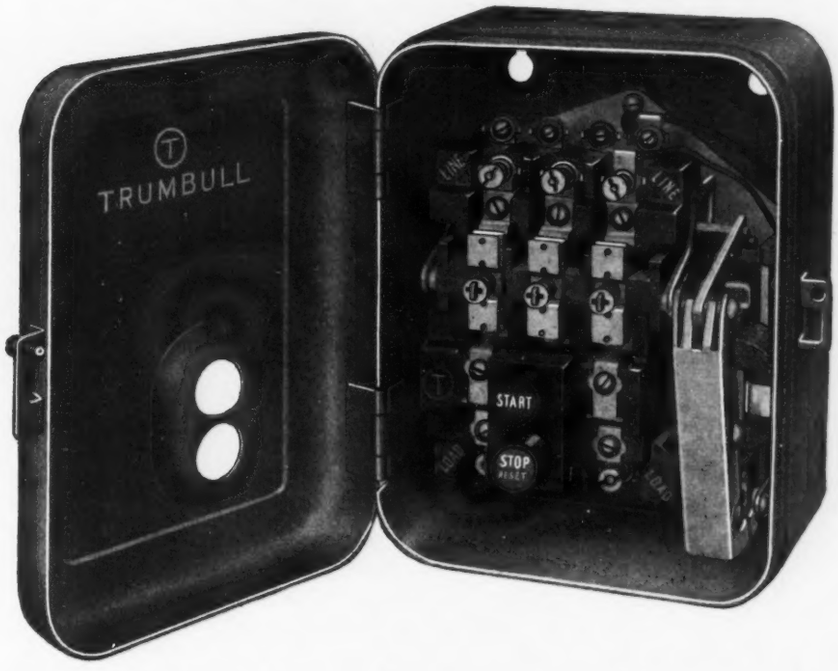
No switch is better than its CONTACTS

TYPE

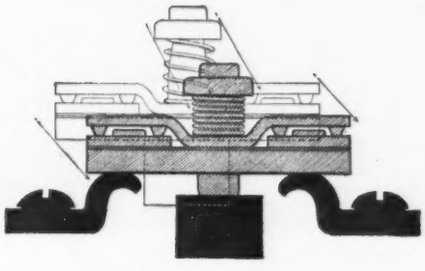
"M 7½"

H.P. RATINGS

Volts A.C.	Poly-Phase	Single Phase
115	3	1½
230	5	3
460	7½	5
575	7½	5



No contacts are better than the new Ⓣ simultaneous DUO-BREAK CONTACTS



Shaded portion shows double break butt contact closed. Lighter drawing shows same open. Arrows show diagonal movement of closing which produces a wiping contact under spring pressure.

NEW CONTACT CONSTRUCTION

The outstanding necessary feature in a magnetic motor starting switch is a MAXIMUM HIGH INTERRUPTING CAPACITY.

Therefore to increase this capacity in a switch of the SMALLEST PRACTICAL SIZE has been the aim of our engineers.

The invention of an entirely new contact construction—the SIMULTANEOUS DOUBLE-BREAK WIPING CONTACT—has solved the problem.

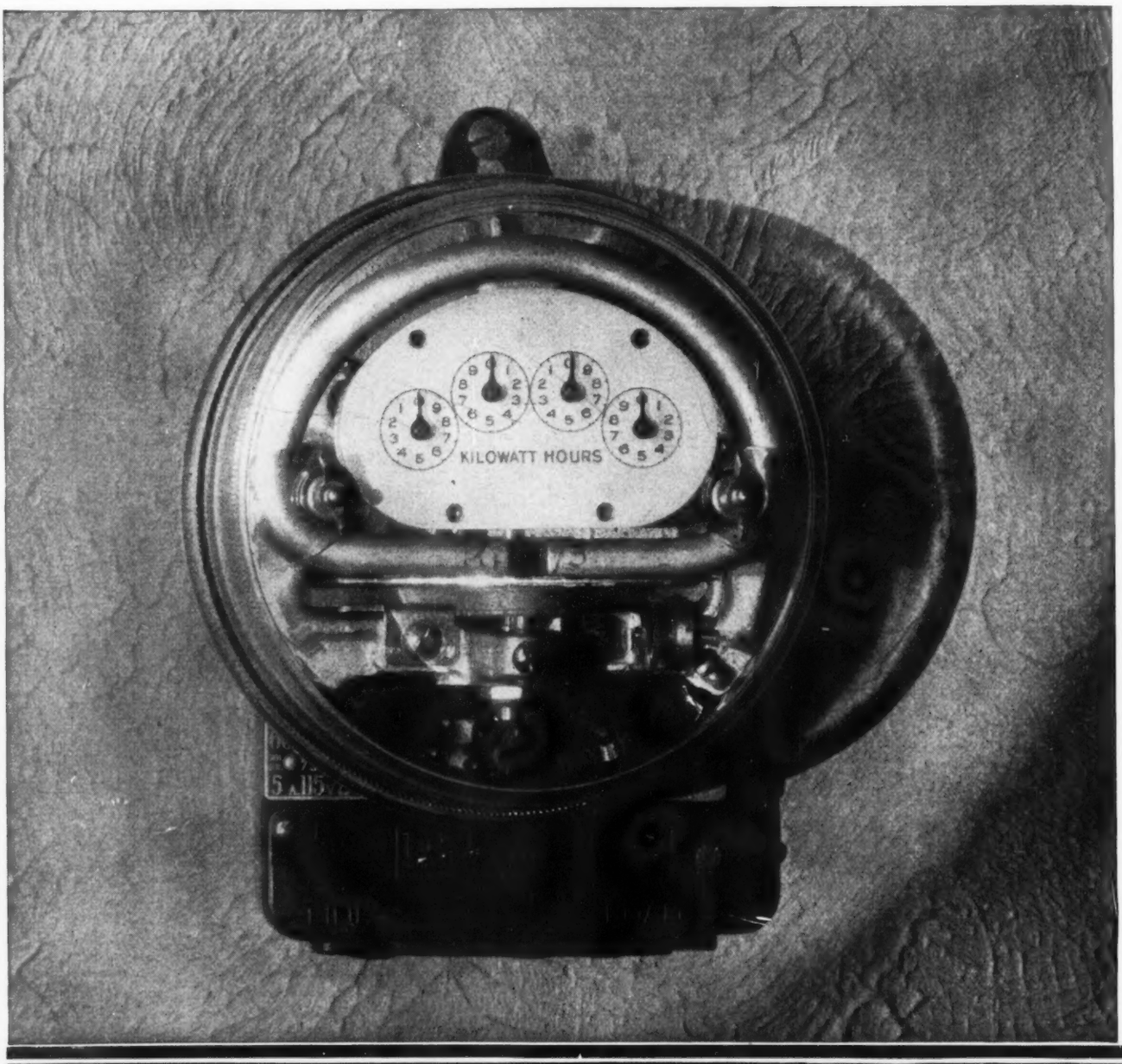
Overload protection has thus been greatly increased and the arc reduced to a minimum of not more than 1/20TH of what it would be under the usual single break contact construction.

Cat. 14 listing the complete "Circle T" Line of Magnetic and other Motor Starting and Enclosed Switches as well as Panel Boards will be sent upon request.

The Trumbull Electric Mfg. Co.

Plainville, Connecticut

New York	Boston	San Francisco	Chicago	Philadelphia	Ludlow, Ky.
114 Liberty St.	1002 Statler Bldg.	595 Mission St.	2001 W. Pershing Rd.	511-519 N. Broad St.	Atlanta, Ga.



BY reason of their consistent accuracy, through a wide range of load conditions, Duncan MD Watthour Meters are chosen by the central stations to safeguard their incomes.

Then, too, their sound design and rugged simplicity assure the maintenance of this accuracy over long periods of trouble-free service.

DUNCAN ELECTRIC MANUFACTURING COMPANY, LAFAYETTE, INDIANA

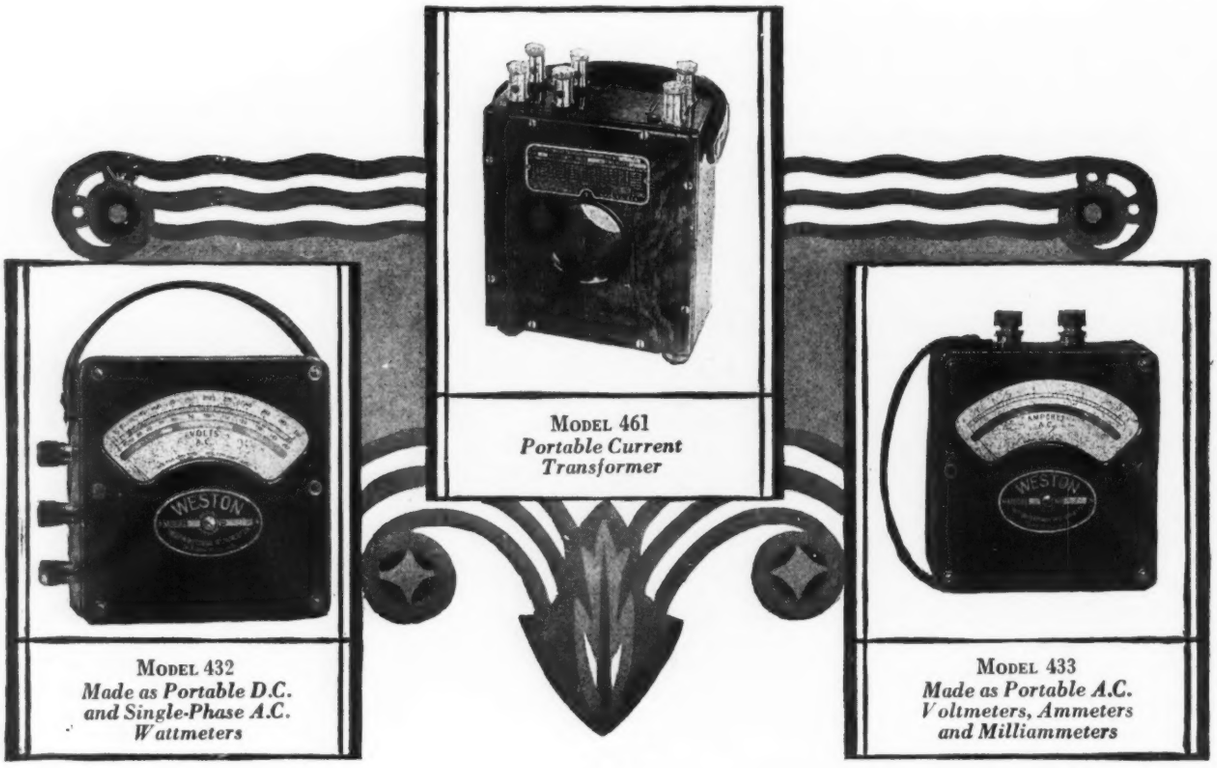
DUNCAN
for
sustained
accuracy

Your Income

DUNCAN
for
sustained
accuracy

is dependent on the accuracy of your Watthour Meters

DUNCAN
Watthour Meters



MODEL 461
Portable Current Transformer

MODEL 432
Made as Portable D.C. and Single-Phase A.C. Wattmeters

MODEL 433
Made as Portable A.C. Voltmeters, Ammeters and Milliammeters

The "General Practitioner" for Electrical Maladies

Electrical systems, like the human body, frequently need doctoring. For all-round testing service the Weston "JUNIORS" can always be depended upon to give a correct *diagnosis* of alternating current conditions.

Like the *general practitioner*, Weston "Juniors" combine the requisites for treating all conditions of electrical apparatus met with in the daily round of service calls, and they have sound organs and a sturdy physique capable of withstanding the hardest kind of usage.

Weston "JUNIORS" possess characteristics emulative of the sensitive Laboratory Standards. In addition, they are light and compact and most reasonably priced. In all respects they are ideally suited to the requirements of field and factory inspection work.

While they are made as portable instruments they are widely used for production testing in the manufacture of electrical products. In fact, they have met with unusual popularity in practically every field and for all manner of testing.

The Weston "Junior" line includes five types of instruments: D.C. and Single-Phase Wattmeters, A.C. Ammeters and Voltmeters and Current and Potential Transformers. The Wattmeters, Ammeters and Voltmeters are enclosed in strong bakelite cases, fully shielded from stray magnetic fields. They are supplied with knife-edge pointers and mirror scales and possess every constructional refinement associated with highest Weston quality.

For a surprisingly low investment a combination of these instruments can be made up from standard ranges that will meet the needs of any electrical department, whatever the size or nature of the plant.

Weston sales and engineering service is world-wide. Whatever your testing problem our instrument specialists will be only too glad to help you in its solution. Call our nearest office. It entails no charge or obligation.

WESTON ELECTRICAL INSTRUMENT CORPORATION
578 Frelinghuysen Avenue Newark, N. J.

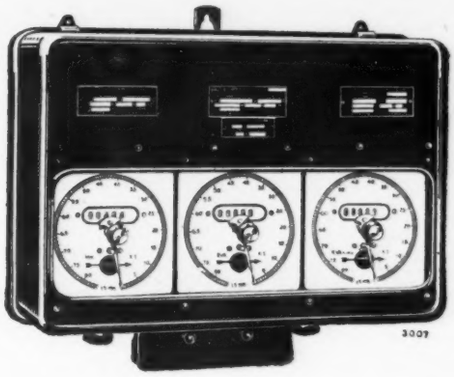
Weston
PIONEERS SINCE 1888
INSTRUMENTS

For Considering

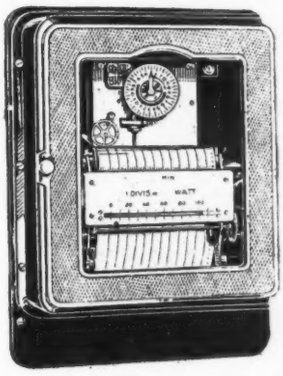
POWER FACTOR

Measure Kva. Hours and Demand with:

The Trivector is furnished with demand indications . . .



or is combined with the Maxigraph for a chart record of the demand.



The MAXIGRAPH

The TRIVECTOR

Consideration of Power Factor necessitates metering equipment to obtain Kva. hours and Kva. demand.

The Trivector is the most suitable apparatus to obtain these measurements.

Simplicity of maintenance, accuracy in registration, flexibility of application, the possible 360° range of registration i.e. to obtain all the desired data for lagging and leading power factor if desired, make the Trivector outstanding among apparatus available for these metering requirements.

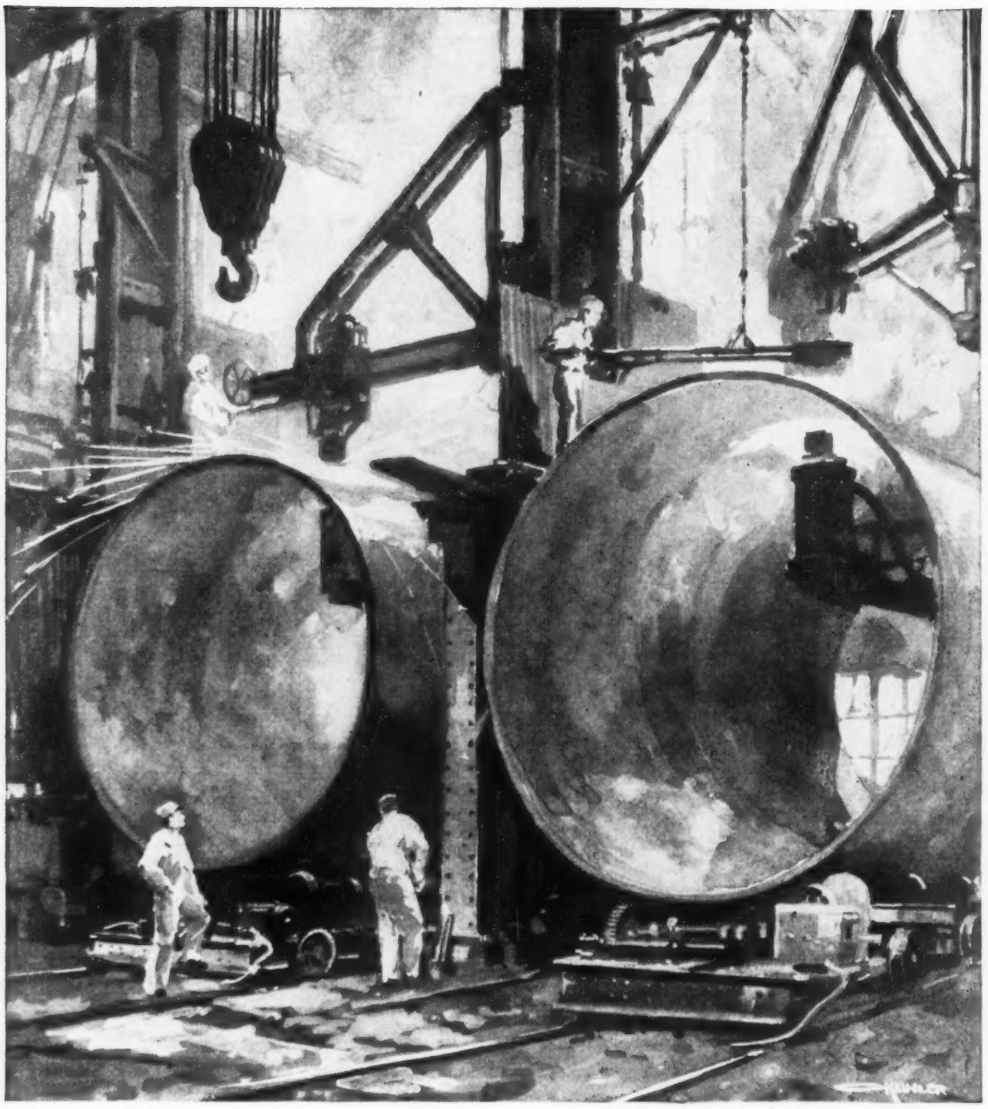
Sixty-four different registering combinations are possible with the Trivector.

Submit your problems to

LANDIS & GYR, Inc.
Herbert Nehls, Vice Pres. and Gen. Mgr.
104 Fifth Ave., New York, N. Y.

Know LANDIS & GYR

The Largest Line of Electricity **METERS** in the World. See Bulletins



Kellogg Pressure Vessels are free from strain

Through hot bending and forge and hammer lap welding, Kellogg produces pressure vessels which are entirely free from cold working strains. Unlike riveted units, Kellogg boiler drums and other vessels resist caustic attack, providing greater safety, longer life and exceptional economy.

THE M. W. KELLOGG COMPANY, 225 BROADWAY, NEW YORK

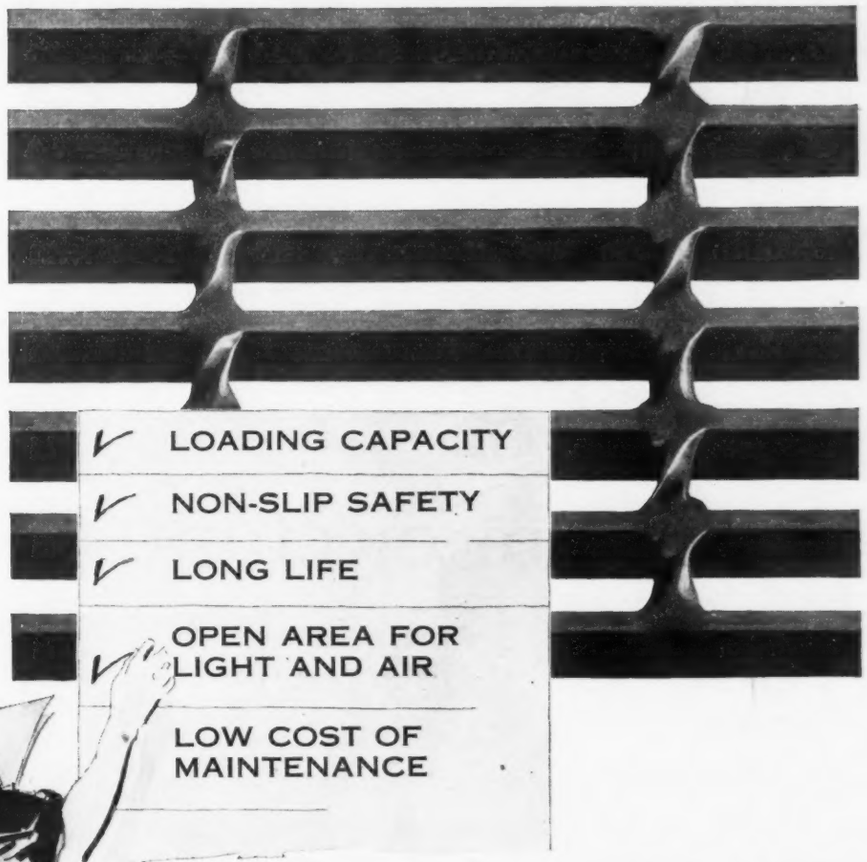
Boston, 12 Pearl St.; Chicago, 53 W. Jackson B'lvd; Pittsburgh, Oliver Bldg.; Birmingham, 827 Brown-Marx Bldg.; Los Angeles, 1031 So. Broadway; Houston, 1514 Petroleum Bldg.; Tulsa, Philtower Bldg.

KELLOGG

PLATES FOR KELLOGG FORGE AND HAMMER LAP WELDED DRUMS ARE HOT BENT, AND THE DRUMS ARE DESIGNED AND BUILT IN ACCORDANCE WITH A. S. M. E. BOILER CODE

ALL KELLOGG FORGE AND HAMMER LAP WELDED PRODUCTS ARE INSURABLE

BLAW-KNOX STEEL GRATING



Each and All are Maximum in

BLAW-KNOX *Electroforged*

STEEL GRATING *and* OPEN FLOORING

No thoroughbred rates a blue ribbon on one feature alone—he must be close to maximum in all departments. Blaw-Knox ELECTROFORGED One Piece GRATING is high in every desirable quality requisite in open flooring. Nationally known engineers have recognized the completeness of its qualifications. We want *you* to judge it for yourself, and assign your own values. Let us send you a sample and complete descriptive literature. Just address our nearest District Office.

BLAW-KNOX COMPANY

613 Farmers Bank Bldg., Pittsburgh, Pa.

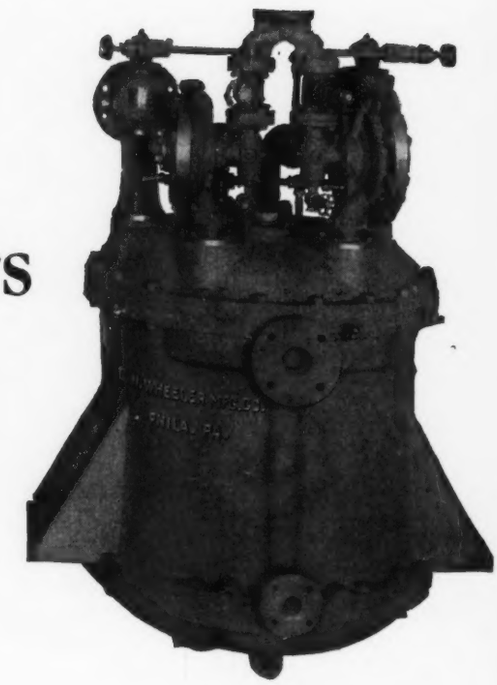
New York, 342 Madison Ave.
Chicago, Peoples Gas Bldg.
Birmingham, Brown-Marx Bldg.
Cleveland, Union Bldg.
Detroit, Lincoln Bldg.
Philadelphia, Widener Bldg.
Baltimore, Bayard & Warner Streets
Boston, Statler Bldg.
Buffalo, Genesee Bldg.

BLAW-KNOX

TRADE MARK REG. U.S. PAT. OFFICE BLAW-KNOX

The RADOJET

Unique in the field of steam ejectors



Two two-stage RADOJETS with combined surface Inter- and After-Condenser

Has the following features which no other steam ejector possesses:—

1. A single annular nozzle the *expansion of which can be adjusted during operation* and without change in steam consumption, giving highest efficiencies under various operating conditions.
2. A radial steam jet, giving *about five times greater entrainment surface* than a tubular jet of equal length.
3. *High penetrating effect* into the diffuser with resultant reduction in entrainment losses and increase in entrainment efficiency.

RADOJETS are successfully employed in the various processes of electrical manufacturing requiring a high vacuum.

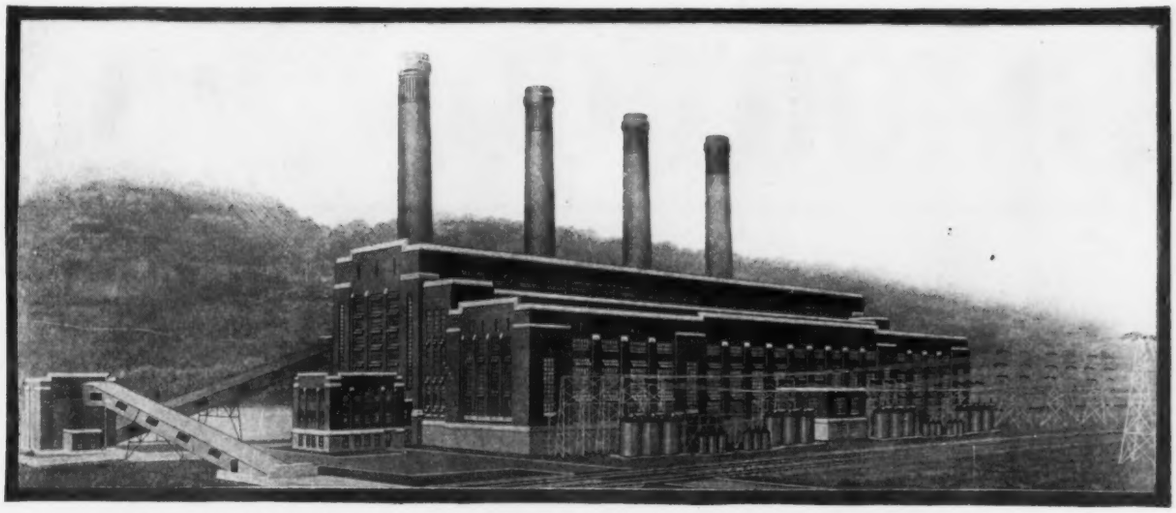
Our engineers are always ready to co-operate with you on your vacuum problems.

We manufacture:

Surface, Jet and Barometric Condensers; Leach Fracto Control Condensers; Oil Vapor Condensers; Heat Exchangers; Radojet Air Pumps for vacua up to 29.95 inches; Forced and Natural Draft Cooling Towers.

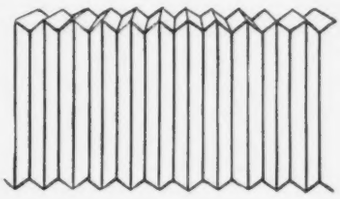
C. H. WHEELER MFG. CO., 19th ST., Lehigh and Sedgley Aves., Philadelphia, Pa.

C.H.WHEELER OF PHILADELPHIA



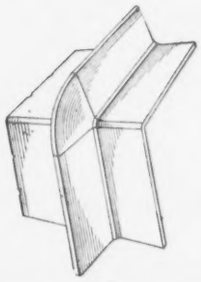
The new Holland Station of the New Jersey Power and Light Company on the Delaware River near Easton, Pa., (W. S. Barstow & Co., Engineers, Reading, Pa.) The ultimate capacity of this station will be 220,000 kw.

One after another modern power plants select Connery Construction for flues, breechings, uptakes, ducts



The huge new modern Holland Station of the New Jersey Power and Light Company, (W. S. Barstow & Co., Engineers) is one of the latest power stations to select Connery Construction to prevent buckling, warping or collapsing in flues, breechings, uptakes, ducts.

Connery Construction is the choice of hundreds of firms because of its flexibility, rigidity and tightness. It is based on a proved principle—that of the accordion which permits the maximum of expansion and contraction. Electric welding throughout makes Connery Construction air and moisture tight with no possibility of internal corrosion. There are no sliding joints.



Examine an accordion. Stretch it out and see how the pleats conform to the pull. Contract it—again the pleats answer to the new shape without buckling, warping or collapsing.

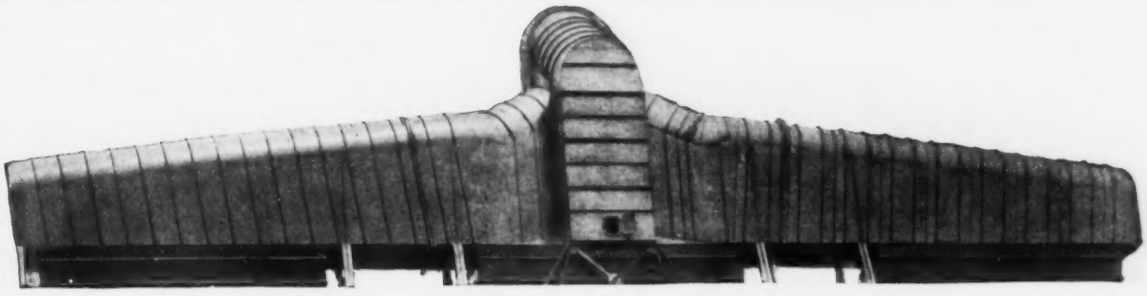
Showing how all corners and laps of Connery Construction are electrically welded to prevent internal corrosion.

Although it is built for a lifetime of service, Connery Construction COSTS NO MORE than regular construction. Let us bid.

CONNERY & COMPANY, INC.

Second and Luzerne Sts., Philadelphia, Pa.

Branch Office, New York



SMOOT CONTROL

These Representative Boiler Plants

with a wide variety of firing equipment are operated by

Centralized Smoot Control of Combustion

Chrysler Corp.
Unit Mill Firing

Packard Motor Car Co.
Underfeed Stokers

Boston & Albany R.R.
Underfeed Stokers

The N.Y., N.H. & H. R.R. Co.
Unit Mill Firing

American Glantzstoff Corp.
Underfeed Stokers

Detroit City Gas Co.
Single Retort Stokers

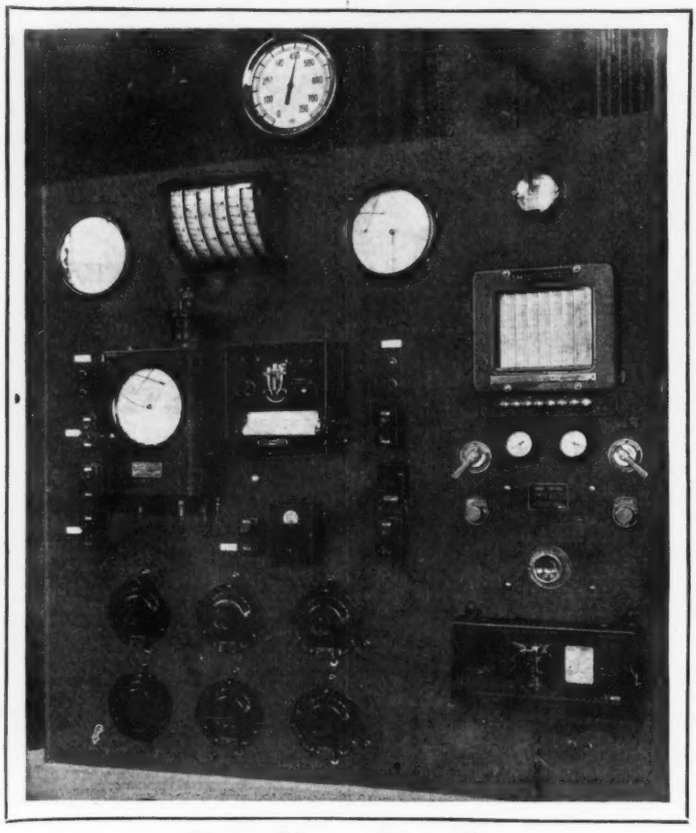
The Brooklyn Union Gas Co.
Traveling Grate Stokers

United Piece Dye Works
Traveling Grate Stokers

Bethlehem Steel Co.
Blast Furnace Gas

American Cyanamid Corp.
Oil Firing

Comal Power Co.
Pulv. Lignite Firing



Smoot Master Controller

National Sugar Co.
Underfeed Stokers

Alabama Power Co.
Bin System Pulverized Coal Firing

Hawaiian Electric Co.
Oil Firing

New Brunswick Power Co.
Unit Mill Firing

Deep Water Station
Unit Mill and Bin System

Gulf States Steel Co.
Blast Furnace Gas

Anglo-Canadian Pulp & Paper Co.
Underfeed Stokers

Anheuser-Busch, Inc.
Unit Mill Firing

Public Service Electric & Gas Co.
Traveling Grate Stokers
Underfeed Stokers

New York Edison Co.
Bin System Pulv. Coal

Anaconda Copper Co.
Unit Mill Firing

The Smoot Master Controller centralizes the control of a boiler plant in a panel which also provides space for the necessary instruments and controls.

Smoot Control of Combustion provides through a **Smoot Master Controller** at each of these plants—

Uniform Steam Pressure

Uniform Excess Air or CO_2

Division of Load among boilers

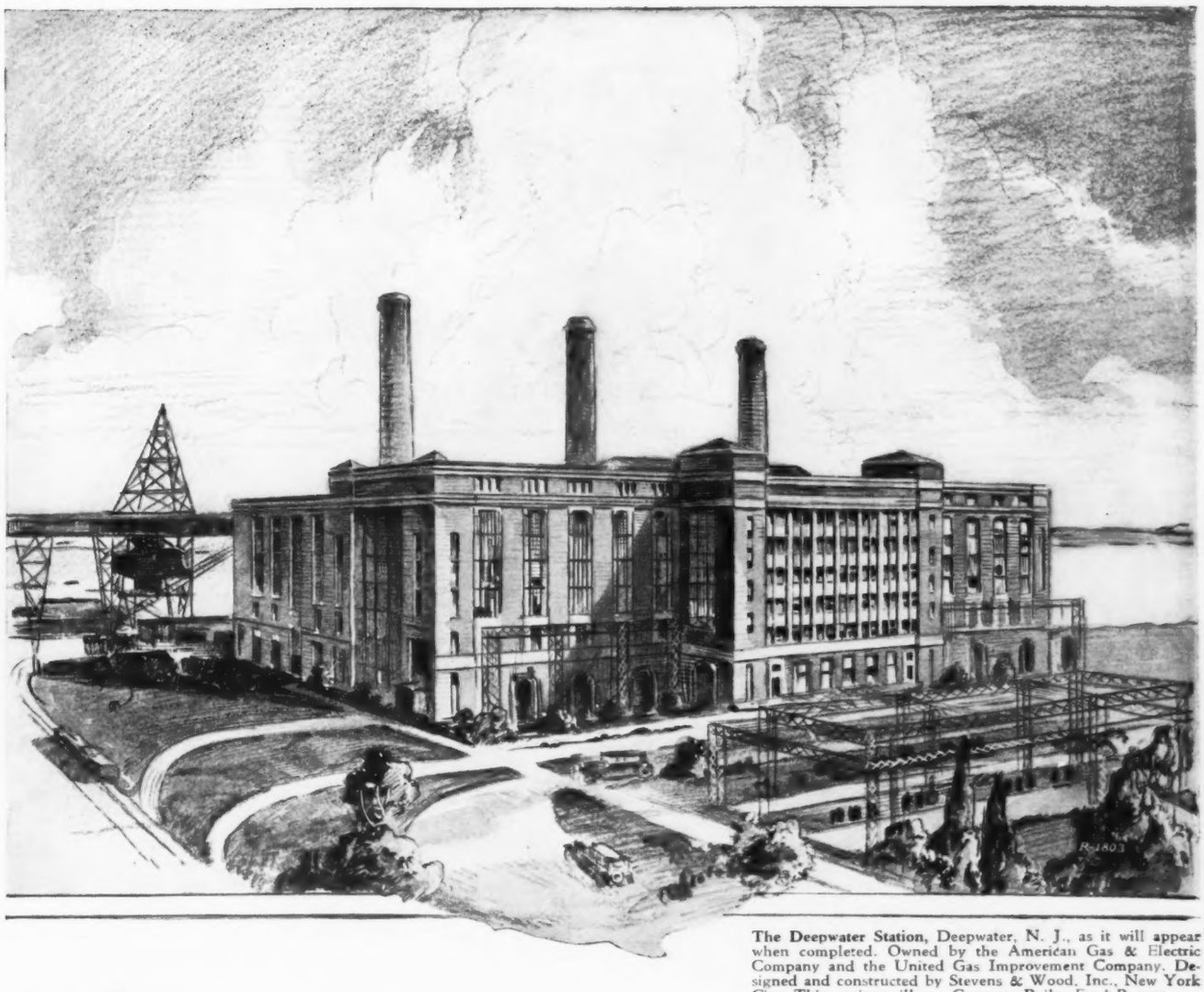
Centralization of Responsibility for Combustion Conditions in one operator at the panel

Adjustment of Fuel and Air Supplies, Boiler Rating, Fan Speed, etc., from the central panel while the boilers are operating

Fast Flexible Regulation, regardless of load fluctuations.

SMOOT ENGINEERING CORPORATION

136 Liberty Street **New York**



The Deepwater Station, Deepwater, N. J., as it will appear when completed. Owned by the American Gas & Electric Company and the United Gas Improvement Company. Designed and constructed by Stevens & Wood, Inc., New York City. This station will use Cameron Boiler Feed Pumps.

another

Central Station with Ingersoll-Rand and Cameron Equipment

The Deepwater Station is one of the first complete high-pressure plants to be built in this country.

Steam will be generated at 1350 lbs. pressure, 725 deg., to supply three turbine-generators. Two of these are 53,000-kw. cross-compound units, taking steam over the whole range from boiler to condenser. The third is a 12,500-kw. high-pressure unit, which will exhaust into evaporators furnishing steam at 180 lbs. pressure for process use in a large industrial plant.

This station will burn pulverized coal.

Ingersoll-Rand and Cameron Equipment for the Central Stations:

Surface Condensers
Boiler-Feed Pumps
Circulating Pumps
Condensate Pumps
Service Pumps
Vacuum Pumps
Pneumatic Tools
Paving Breakers
Air Compressors

INGERSOLL-RAND COMPANY 11 Broadway • New York City

Branches or distributors in principal cities the world over

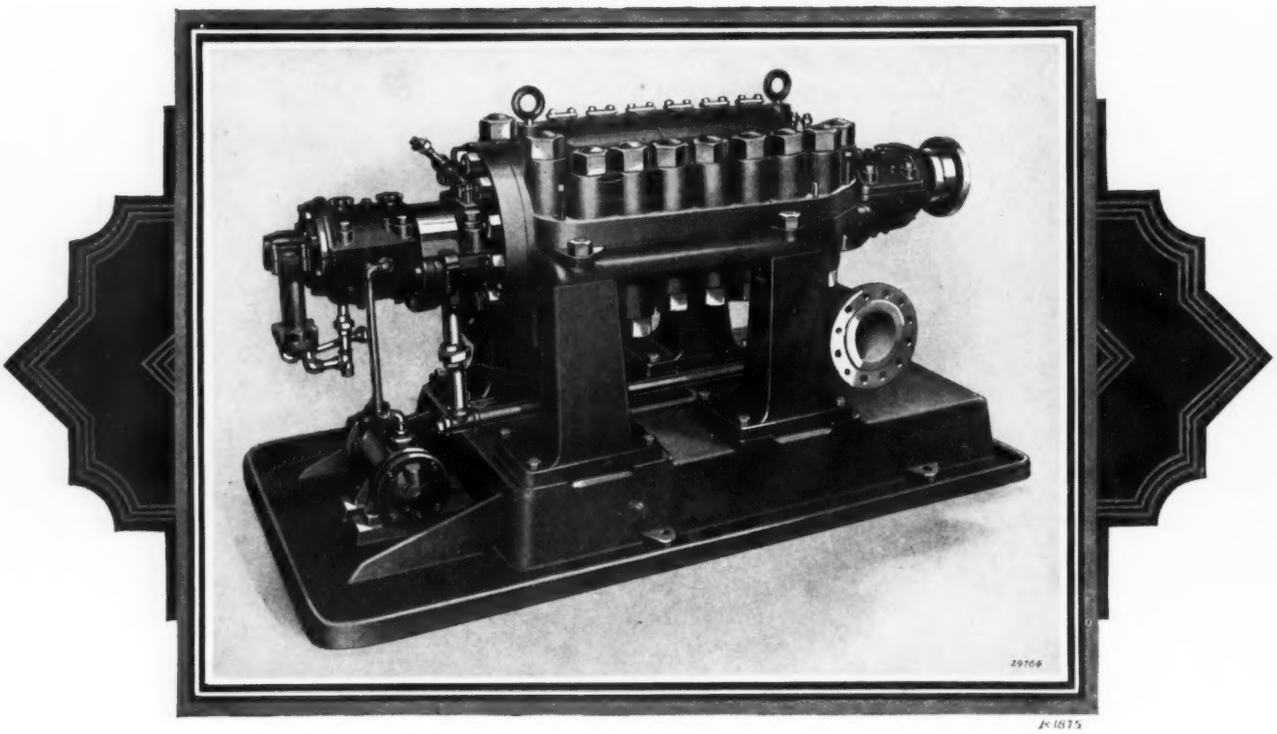
For Canada Refer—Canadian Ingersoll-Rand Co., Limited, 10 Phillips Square, Montreal, Quebec

342-DV

Ingersoll-Rand

A. S. Cameron Steam Pump Works

(over)



Cameron Boiler Feed Pumps—

Because its energies have been dedicated to progress, Cameron has always been the pacemaker in the field of pump manufacture.

Fifteen years ago, Cameron Centrifugal Boiler Feed Pumps were built for pressures up to 300 lbs. and were considered the pioneers and leaders in this class of equipment.

Today, Cameron Boiler Feed Pumps are built for pressures up to 2,000 lbs. and for capacities ranging from 125 to 3,000 gals. per minute. They set a new standard for this type of service and Cameron is still the pioneer—is still the leader.

INGERSOLL-RAND COMPANY · 11 Broadway · New York City

Branches or distributors in principal cities the world over

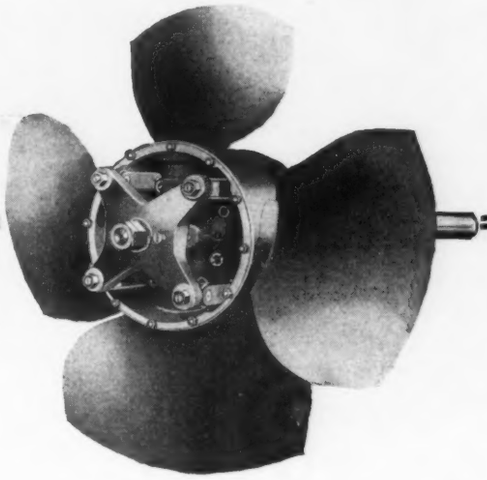
For Canada Refer—Canadian Ingersoll-Rand Co., Limited, 10 Phillips Square, Montreal, Quebec

357-DV

Ingersoll-Rand

A. S. Cameron Steam Pump Works

The SMITH - KAPLAN
HIGH SPEED TURBINE



—*for*

Low head, or Run-of-River Water Powers

The Smith-Kaplan Automatically Adjustable Blade High Speed Turbine gives remarkably high efficiencies over a wide range of head and load conditions. The resultant increase in Annual Kilowatt-hour output, makes it possible to develop low head or run-of-river water power sites. which have heretofore been considered economically impossible.

Write for Bulletin No. 122

It is a significant fact, that over 6.000.000 Horsepower of Smith Turbines are now in use or under construction.

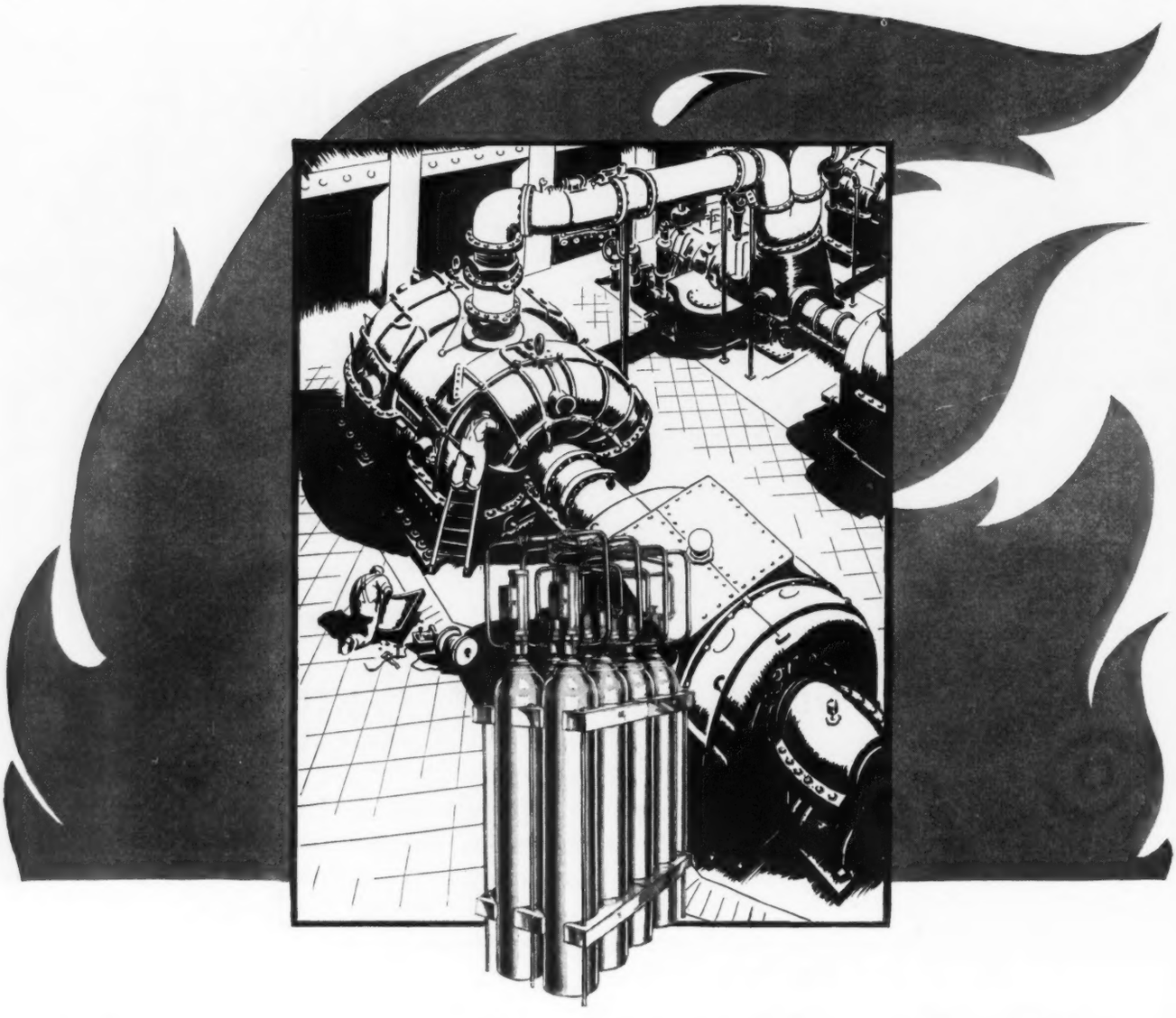
Smith Turbines are built in the World's Largest exclusive Hydraulic Turbine Plant. —and are backed by over 50 years' continuous experience.

S. MORGAN SMITH CO. HYDRAULIC TURBINES

Department W **York, Penna., U. S. A.**

Boston—Chicago—Salt Lake City—Denver—Portland, Ore.—San Francisco
(Associated Company—S. Morgan Smith-Inglis Co., Ltd., Toronto, Canada)

KILL FIRE WHILE IT IS YOUNG



The cure may be worse than the bite ...unless ALFITE stands guard

You may put out fires in electrical equipment with water, steam, or liquid chemicals. But it is apt to mean shutting down for a long time. The aftermath of drying out coils and getting rid of corrosion may cost you more than the fire itself.

The ALFITE System kills the fire instantly by flooding the fire space with ALFITE Gas, in which fire cannot live. Because ALFITE Gas is harmless to insulation and will not cause corrosion—it restricts the loss to actual *fire damage*.

The ALFITE System provides sure, scientifically regulated control of this gas. It assures instant discharge the moment fire is detected. The ALFITE discharge valve assures rapid and complete discharge when fire occurs. Control may be automatic, semi-automatic, or manual.

The ALFITE System is moderate in cost. American-LaFrance and Foamite engineers have made it the simplest system possible to design. If you are interested, an engineer will, without obligation to you, call and give you further information. American-La France and Foamite Corporation, Engineers and Manufacturers, Dept. N-31, Elmira, N. Y.

AMERICAN-LA FRANCE AND FOAMITE PROTECTION

A Complete Engineering Service

For Extinguishing Fires

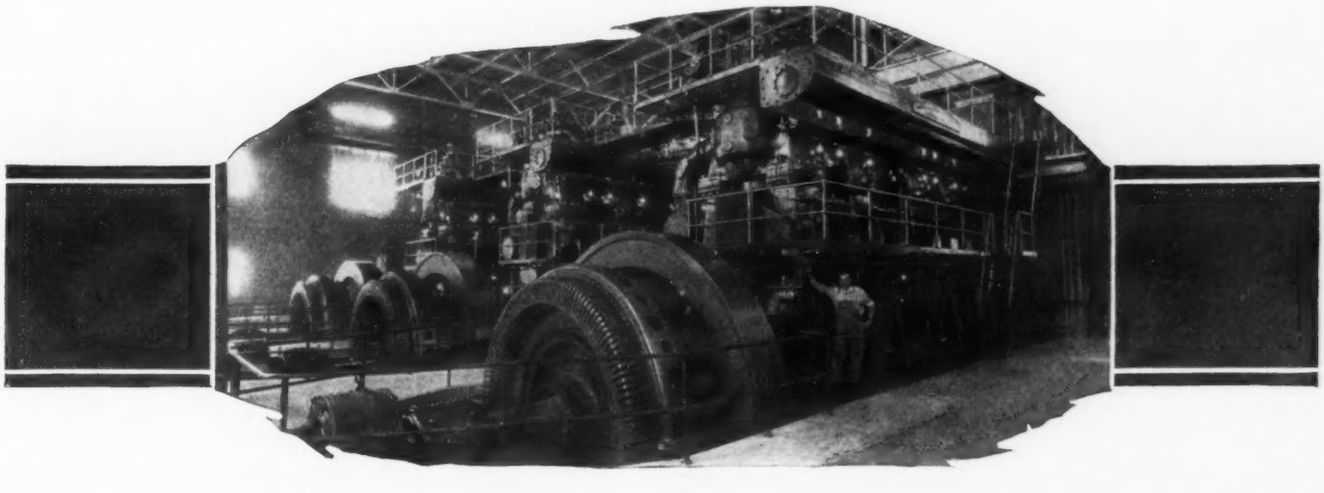
23 hours every day!

This Nordberg Diesel Engine installation of the Commerce Mining & Royalty Company, Miami, Oklahoma, uses its Sharples Oil Purifier 23 hours every day for clean oil protection.

From 3000 gallons of "lube" oil handled daily, the Sharples removes 6 to 8 pounds of dirt and solids. Imagine the effect upon engine bearings and maintenance costs if these impurities were not removed from the lubricating system!

For safe, clean oil—"lube" and fuel—there is no substitute for a Sharples!

THE SHARPLES SPECIALTY COMPANY, 2314 WESTMORELAND STREET, PHILADELPHIA. Boston, New York, Baltimore, Pittsburgh, Chicago, Detroit, Tulsa, New Orleans, San Francisco, Los Angeles, Toronto, London, Paris, Tokio.



WHEN governor problems arise our comprehensive experience will be of value to you. "Write for Catalogue M."

WOODWARD GOVERNOR CO., Rockford, Ill.

WOODWARD
WATER WHEEL
GOVERNORS

Tanner Instruments

are neat in appearance and of rugged construction. They are used for electrically transmitting to a distance any kind of mechanical movement such as liquid levels, position of head gates, valves, gas holders, etc. *Write for bulletins.*

TANNER ENGINEERING COMPANY INC.
RAWSON ST. AND NELSON AVE.
LONG ISLAND CITY, N.Y.

All the News isn't in the News Section

Let the advertising pages of *Electrical World* keep you in touch with new products, new policies of manufacturers and new services available.

THE BABCOCK & WILCOX COMPANY

85 LIBERTY STREET, NEW YORK

Manufacturers of

Water-Tube Boilers, Steam Superheaters, Air Preheaters, Economizers, Chain Grate Stokers, Oil Burners and Refractories. Pressure Vessels and Special Process Equipment.

ESTABLISHED 1868

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PHOENIX, ARIZ., Heard Building
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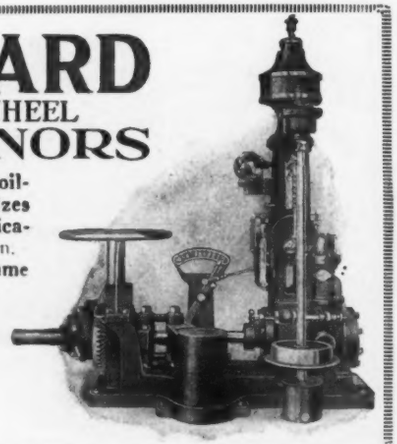
SAN JUAN, PORTO RICO, Recinto Sur 51

LOMBARD
WATER WHEEL
GOVERNORS

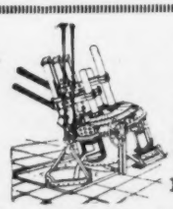
Powerful, quick-acting oil-pressure governors in sizes and types for any application or special condition. For many years, the name LOMBARD has stood for *reliable service* and *closest regulation obtainable.*



THE LOMBARD GOVERNOR CO.
ASHLAND, MASS

HYDRAULIC TURBINES PENSTOCKS
BUTTERFLY VALVES GATES RACK RAKES

NEWPORT NEWS SHIPBUILDING AND DRY DOCK COMPANY
NEWPORT NEWS, VIRGINIA

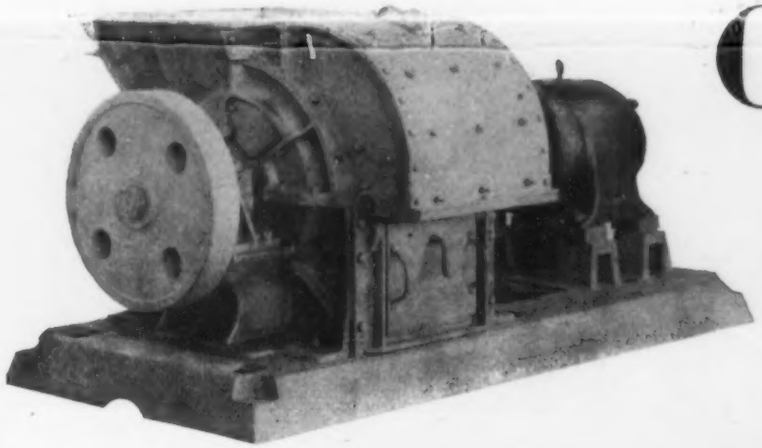


Moore Rapid Lectromelt Furnaces

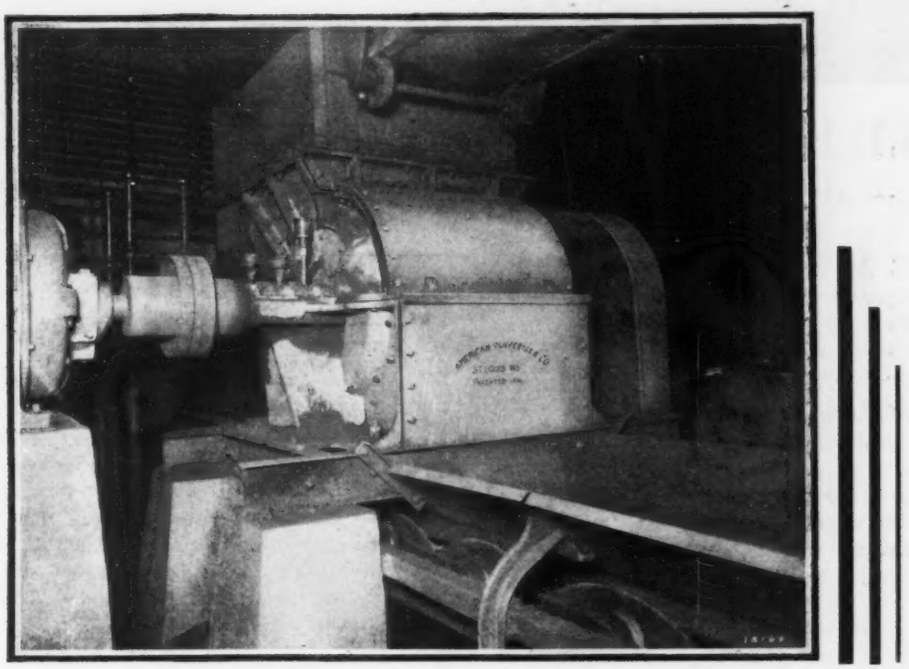
Ten Standard Sizes ½ to 24 Tons Capacity
Most Rapid and efficient for making
Tool Steels, Alloy Steels, Forging Steels
Steel Castings, Malleable Iron, Grey Iron
Carbide, Ferro-Alloys etc.

PITTSBURGH ELECTRIC FURNACE CORPORATION
P.O. Box 1125. PITTSBURGH, PA.

400,000 Tons Coal Crushed



Without One Cent for Repairs



PROVING the high operating efficiency of American Rolling Ring Crushers, we have received numerous reports of over 400,000 tons of coal being crushed without one cent for repairs.

Just recently two reports received were, respectively, 414,000 and 420,000 tons of coal crushed from R.O.M. to ¾ in. and not yet one cent spent for repairs. Why? American Pulverizer Co. are the originators of the Rolling Ring Crusher principle, and have devoted all of their efforts for the past 20 years to refinements in design and manufacturing.

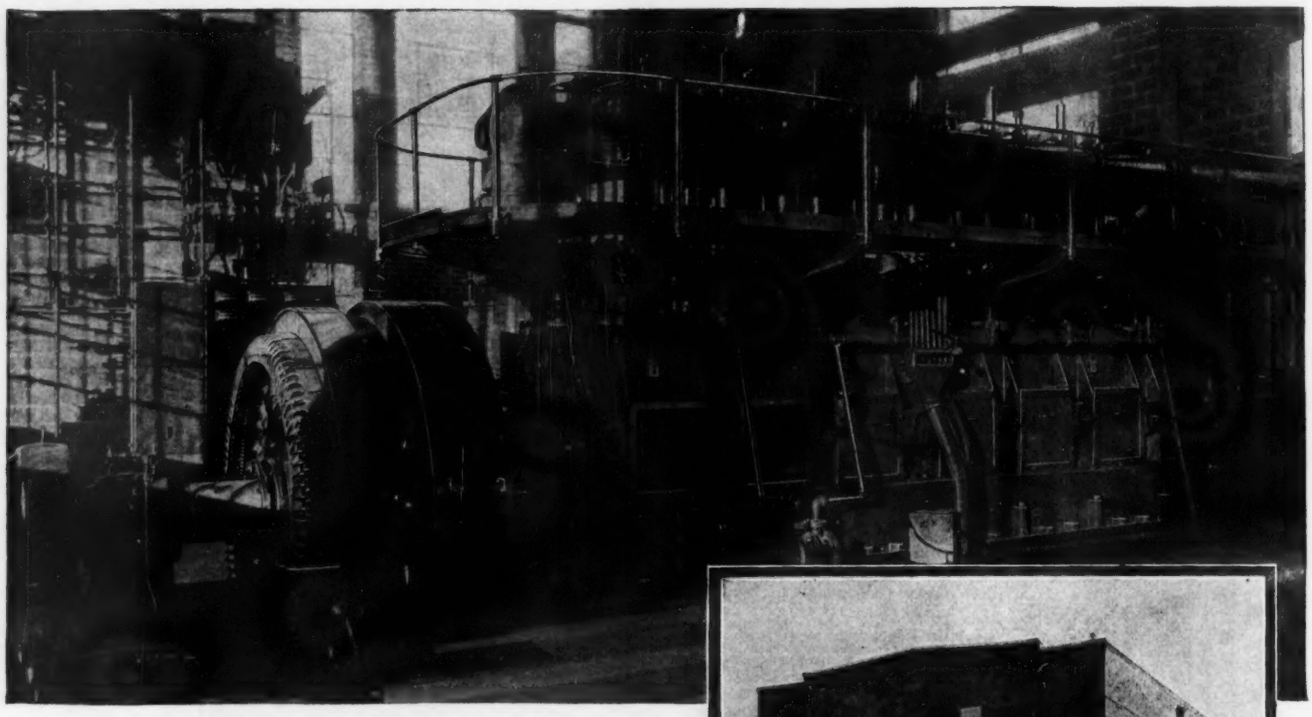
A new modern plant, equipped to make nothing but crushers, has added materially to increased efficiency in the machines themselves and this is handed down to buyers at no increased costs.

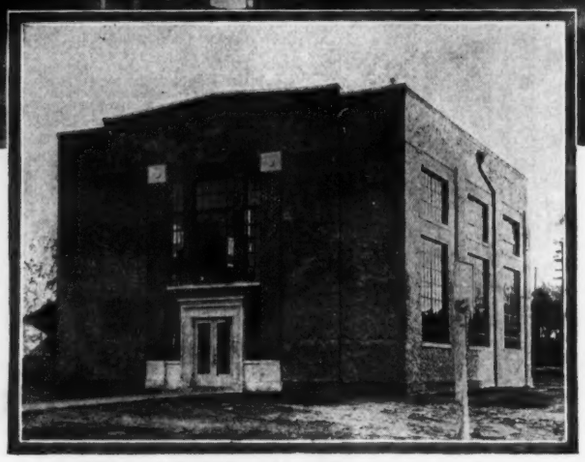
Let us bid on your next requirements, and we will gladly furnish engineering service, if desired, in working up design.

ORIGINATORS OF THE ROLLING RING CRUSHER PRINCIPLE

AMERICAN PULVERIZER CO

1249 MACKLIND AVE · ST·LOUIS·MISSOURI





675 B.hp. standby capacity
—available on 1½ minutes notice

THE above 675-b.hp. 6-cylinder McIntosh & Seymour Engine and its generator are installed as the Moultrie, Ga., stand-by plant of the Public Service Consolidated Corporation, whose main power lines extend from a hydro-electric development.

This McIntosh & Seymour Engine at Moultrie is put into operation during periods of low water, high load and whenever there is an interruption in the water power. Only one operator stays in the plant, and when the call comes, he can bring the engine to speed and throw it on the line within 1½ minutes. The performance of this unit has been entirely satisfactory, as have also the records of three 500-hp. McIntosh & Seymour units operated in Arizona and one 665-hp. unit operated in Canada by companies under observation of the same engineering interests.

If you need extra power to carry the daily peaks, to help out an overloaded plant for intervals of days, weeks or months, or to furnish emergency power at any time, the logical purchase is a McIntosh & Seymour Engine—with characteristic Diesel economy during the working periods, without standby losses while idle, and always dependable for a quick start and full capacity.

Where such units are installed in overloaded steam plants originally with the thought of running the Diesel engine only during the high demand periods, the per hp-hr. saving over operating costs with steam usually proves so great that the Diesel engine soon comes into continuous use and part of the *steam* equipment is shut down when the whole plant is not needed. In this way at least the part of the power supplied by the Diesel engine is most economically generated.

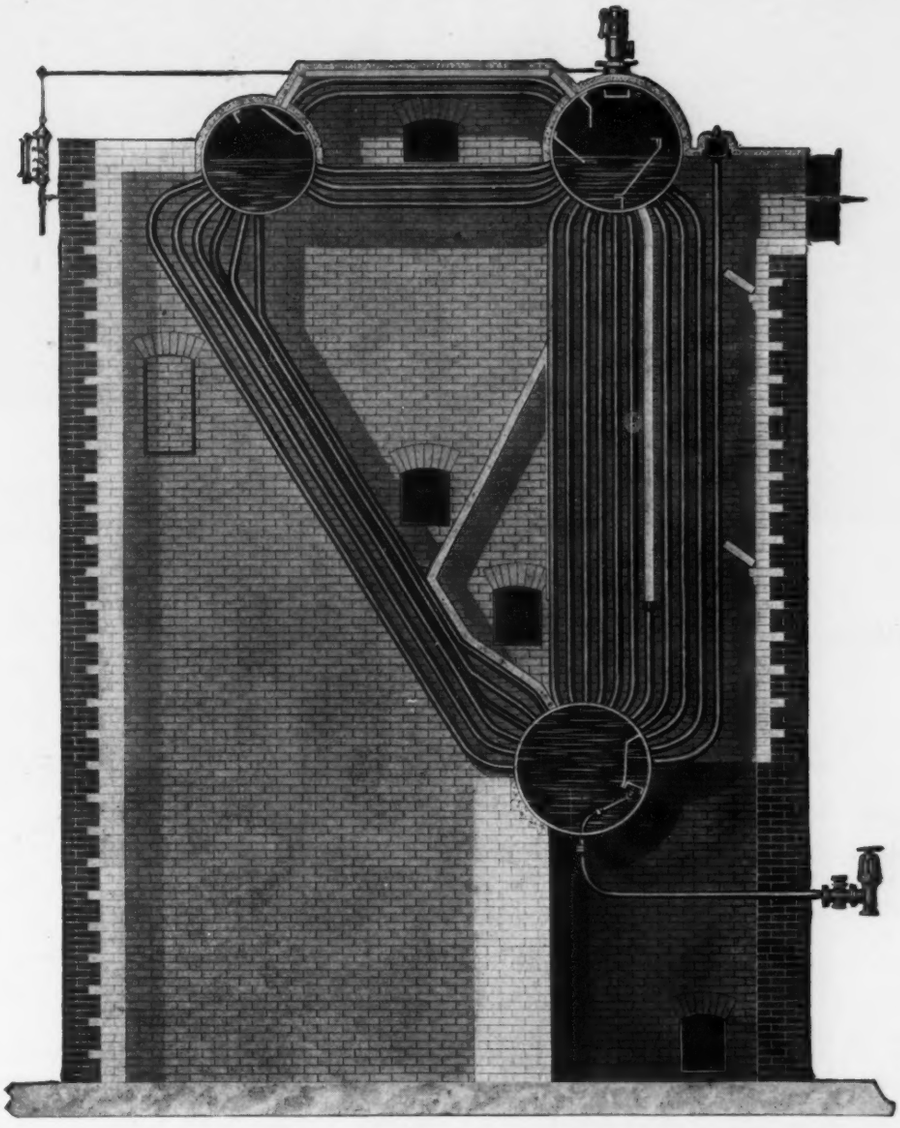
If you need additional power, dependably available at low producing costs, let our Engineers explain how and why a Diesel engine should be utilized. Getting cost and performance data would not obligate you but should point the way to possibilities that you cannot afford to neglect.

McINTOSH & SEYMOUR CORPORATION, *Main Office and Works:* Auburn, N. Y.

New York 149 Broadway | Kansas City, Mo. 1016 Baltimore Ave. | Jacksonville, Fla. 219 Humble Bldg. | San Francisco, Cal. 514 Matson Bldg. | Houston, Tex. 2703 Esperson Bldg.

McINTOSH & SEYMOUR DIESEL ENGINES

For the modern plant of any size—the EDGE MOOR BENT TUBE BOILER



The Edge Moor Bent Tube Boiler is designed especially for modern steam plants. It is excellently adapted for service with such auxiliary equipment as super-heaters, economizers, and air pre-heaters. Operated without these accessories in the smaller plant, it is capable of giving high efficiency with a minimum of maintenance expense.

In every detail of workmanship and material, the Bent Tube Boiler is fully up to the quality set by Edge Moor standards. A half-century of successful experience in boiler building is reflected in its development.

EDGE MOOR IRON COMPANY

Established 1868

EDGE MOOR, DELAWARE

New York *Chicago* *St. Paul* *Los Angeles* *Charlotte*

EDGE MOOR Water Tube BOILERS

STRAIGHT AND BENT TUBE TYPES—WATER WALLS—AIR PREHEATERS

EDGE MOOR BOILERS
EDGE MOOR, DEL. U.S.A.

SHABASH

With the Balkan tribes, tribute goes to the man who displays courage.

Even when tribe chiefs ordain that because a native has departed from established custom his house must be burned, if that man can successfully defend it for three days against those sent to burn it—he escapes the penalty.

His courage is rewarded with the official SHABASH, meaning WELL DONE.

They view it that when a fellow has a righteous cause he is endowed with supernatural fighting powers — and they're right.

Electrical World knows they're right, since this whole issue is devoted to bestowing SHABASH on those having courage to fight tradition and design for today's conditions.

And we of Morganite know they're right, because when the newer and higher machine speeds appeared, we provided the Electro-Graphitic grades of Morganite for this service.

Gracious! how the sparks flew from the carbon brush fundamentalists! and the fight was on.

The gory details, being history, are omitted. Today the Electro-Graphitic grades of Morganite bask in the warm glow of the official SHABASH of modern industry.

Morganite Brush Co., Inc.

Main Office and Factory

3302-3320 Anable Ave., Long Island City, N. Y.

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Baltimore, O. T. Hall, Sales Engineer, 432 North Calvert Street
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San Francisco, Electrical Engineering Sales Co., 222 Underwood Bldg.
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Large Rugged **ENOUGH** To Wire To Last

EXACT SIZE OF THE NEW

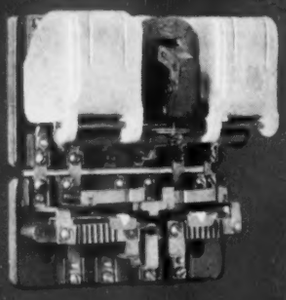
SUNDH ACLINESTOR

ACROSS THE LINE TYPE STARTER

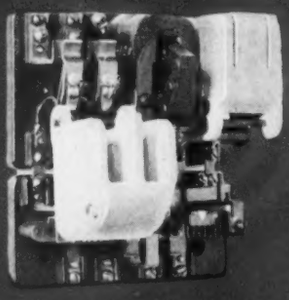
6013 Aclinestor Form M.A. full voltage automatic starter for remote control.

6013 Aclinestor Form M.B. full voltage automatic starter, manual, automatic, and off

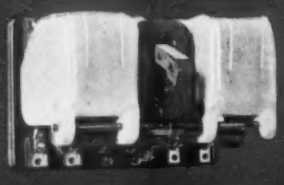
6013 Aclinestor Form M.C. full voltage automatic starter push button control.

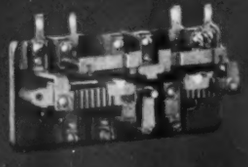


Interior of 6013 Aclinestor automatic push button switch. Note the simple, compact rugged construction, with ventilated arc-shields.



Switch above with arc-shield turned back for inspection of contacts. Switch or door cannot be closed in this position.





Switch and thermal relay are mounted on two separate cold molded bases.

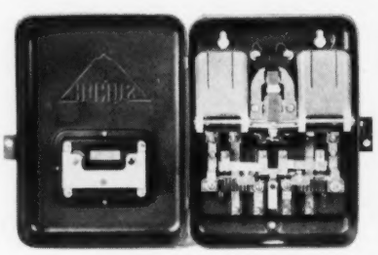
6013—the standard of comparison

Here is a switch by which all other starters can be compared. No testing is required. We have done that for you. It has been tested in air, in a salt bath, in a steam bath, for over load, for life of contacts, for every possible breakdown. We offer you this 6013 Aclinestor as a simple rugged dependable starter that has no superior. Price was not a consideration when we built 6013—it was built to the highest standard.

Note that there is plenty of room at top and bottom for wiring with plenty of knockouts. Also note that the connections go straight from line to load, that everything is compact yet not crowded, that start, stop and reset push buttons are straight through the box. No flexible leads.

Outstanding Features

1. Few moving parts.
2. Rugged construction throughout.
3. Famous Sundh quiet magnet.
4. No iron current carrying parts.
5. Cadinum plated parts throughout.
6. Contacts instantly removable by use of screw driver.
7. To remove coil, loosen 2 screws.
8. Ventilated arc shields of cold molded asbestos.
9. Bakelite molded contact support bar reinforced.
10. Switch and thermal relay on two separate cold molded bases.
11. Thermal overload reset from outside of box.
12. Switches complete in 3 and 4 poles.
13. Thermal overload adjustable for time interval.



Form M. C. Aclinestor with cover open.

14. Built to Underwriters' complete requirements.
15. Accessibility—coil—contacts and thermal relay elements instantly removable.
16. Push button recessed for protection.

Examine this 6013 Aclinestor

Only by examining this switch can you appreciate its superiority in design, construction and appearance. It meets every test and has interrupted stalled rotor current far in excess of its rated capacity. Ask us to send you a sample switch for inspection and trial.

SUNDH ELECTRIC CO., INC.

No. 5 Avenue C

NEWARK, NEW JERSEY

Sales Representatives in all Principal Cities

Do you think it's

Too Good to be True?

Every plant superintendent has dreamed of the time when his plant would be trouble-proof

YES, your plant can be made trouble-proof as far as the flexible couplings are concerned. Flexible coupling troubles can actually be made a thing of the past.

What is it that causes coupling shut-downs in your plant? Almost invariably replacing broken springs, rings, bushings, pins, discs or grids—flexible materials that fatigued and failed. Eliminate the flexible materials and the problem is solved!

How? Fast answered that question. As the diagram below shows, two spur gears are in complete and continuous mesh with the internal gears of a floating sleeve. The sleeve takes a neutral position, the error in misalignment is taken up between the lubricated faces of the gear teeth, and all necessity for flexible materials is eliminated.

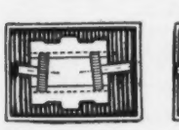
It has been demonstrated mathematically, experimentally and in actual operation of tens of thousands of couplings that there is no metal-to-metal contact between the gear teeth. The oil in the sleeve, under the centrifugal pressure due to revolving of the shafts, is thrown between the faces of the gear teeth, providing an actual oil cushion that carries the load.

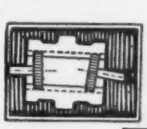
If you are purchasing new equipment—or if you have a danger drive with which you have recurring coupling troubles—let us know. Tell us the kind of equipment, the kind of service, the H. P., the R. P. M., and the shaft diameters, and we will submit prices at once. You will be surprised to find (in most cases) that the cost of the Fast's Coupling is little if any more than the old style. But the difference in performance is so marked that Fast's Couplings are always cheapest in the end.

Also do not fail to send the coupon for the extremely illuminating book by Prof. Moore on "What Happens in Couplings." It's valuable, but it's free. Send for it.

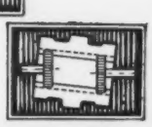
FAST'S
Self-Aligning
COUPLING

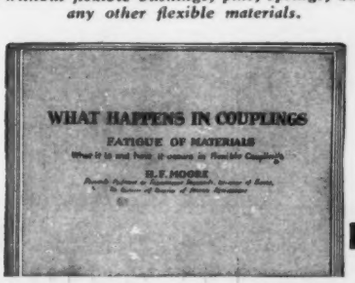
The coupling without flexible bushings, pins, springs, discs, grids or any other flexible materials.





Two spur gears, meshed with the internal gears of a floating sleeve. Coupling revolves as one unit, misalignment being taken up between the lubricated teeth.





Get this authoritative book which clearly shows how flexible materials can be avoided in coupling design.

Sign and mail this Coupon for the Free Book.

THE BARTLETT HAYWARD CO.
208 SCOTT STREET - - - BALTIMORE, MARYLAND

Read Prof. Moore's authoritative discussion of the failure of flexible materials.

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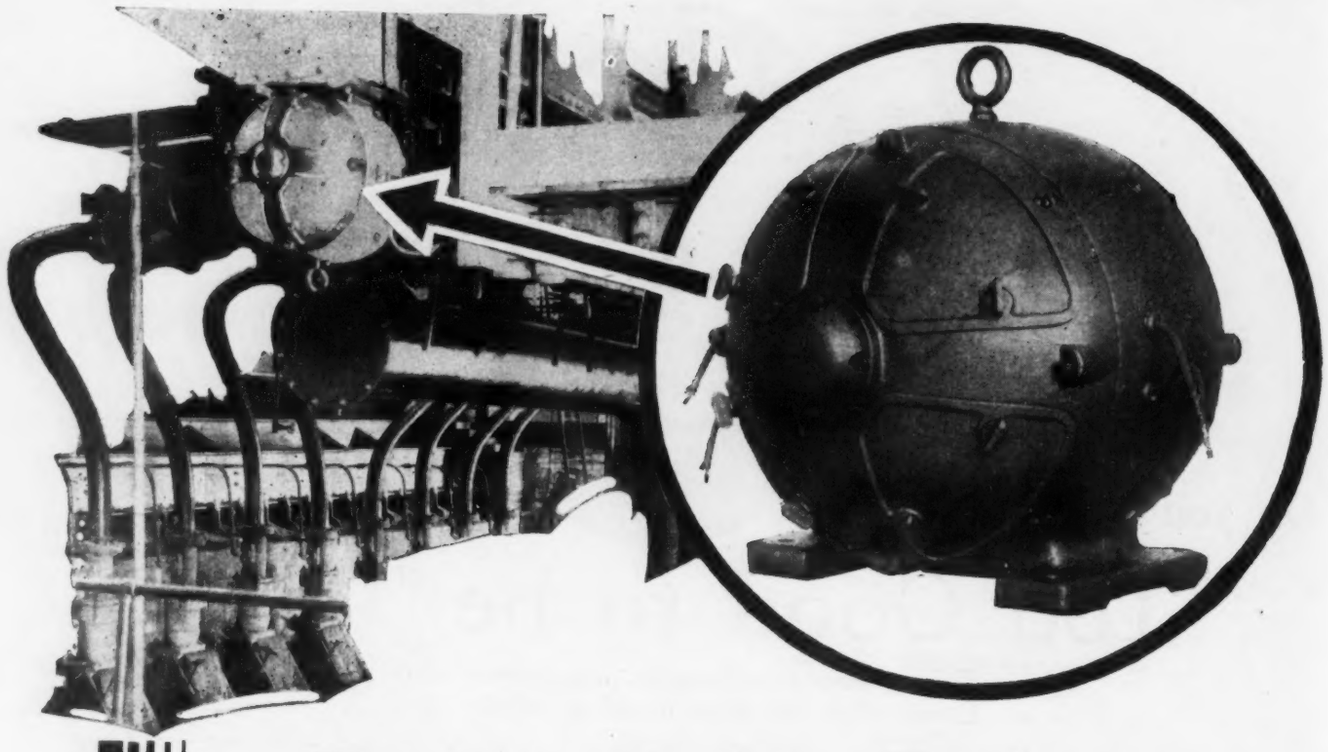


Dependable Drives

MORE than anything else, you want dependability in a motor drive. More than anything else, dependability is characteristic of Electro Dynamic Ball Bearing Motors.

Records of 10, 15 and 20 years of service, with minimum attention and maintenance, can be pointed to in every line of industry. The only way to judge a motor is to judge it by its record—and about the only thing you need to consider in its record is the reliability of its service. *That proves all things.*

If you will make dependable trouble-free service the test of the motor you want for your difficult drives—we will rest our case.

"Quality for Half a Century"

Electro Dynamic Company

Bayonne New Jersey

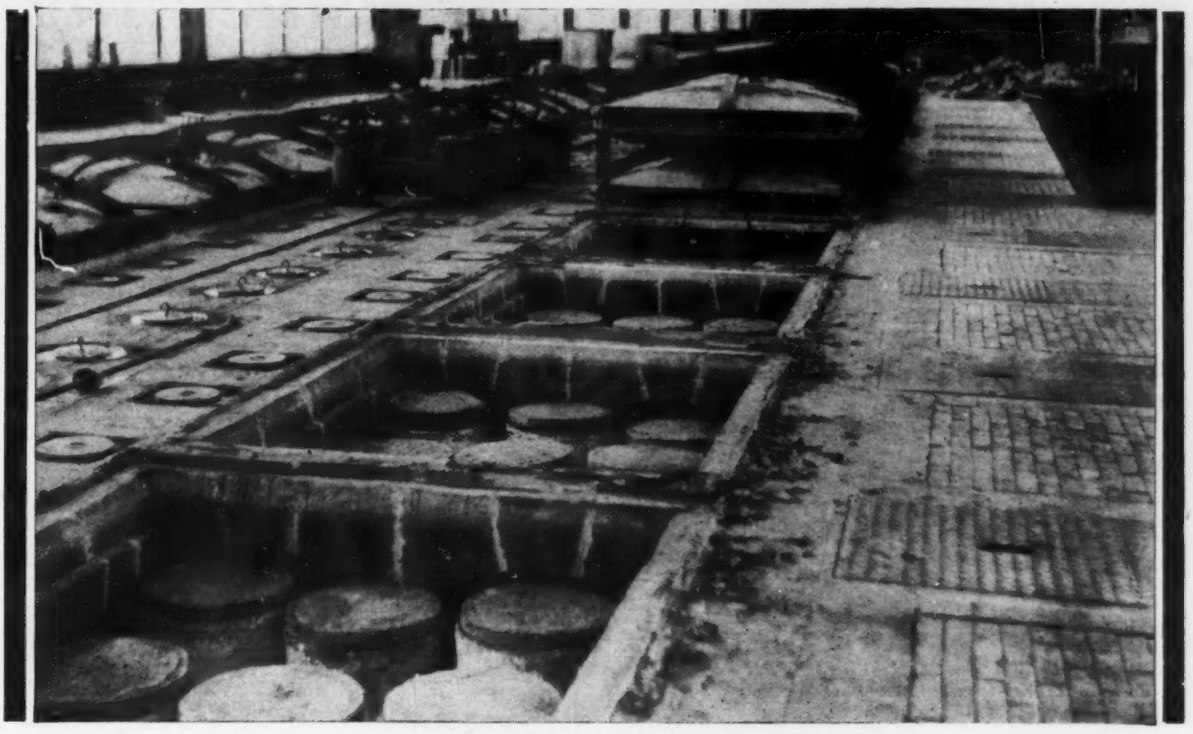
Established 1880

Manufacturers of Alternating Current Motors and Direct Current Motors and Generators

◆◆ BEHIND THE PYRAMIDS—9 ◆◆

N C C

20 days in a unique furnace



View of part of a ring furnace

THE "green" blocks as they come from the moulding machines are entirely unsuitable for use as brushes, though they have gone through eight major manufacturing operations, and innumerable minor ones, all under accurate scientific control. The next operation is baking. This is done in an unusual ring-type furnace, of exclusive design. The blocks, or in the case of small brushes, the pre-formed brushes themselves, are packed in the furnace, which is then fired by gas to a high temperature, carefully kept within close limits. The entire operation takes about 20 days. During it, the pitch binder is carbonized, the blocks and brushes made mechanically strong, and the material given the proper degree of electrical conductivity.

This unusual ring furnace is so arranged as to make continuous operation possible. All operations necessary to this process—loading, heating, firing, cooling, unloading—are conducted continually. In design, in efficiency, and in closeness of temperature control this furnace is most unusual, in fact, unique in brush manufacture.

We feel that our pride in it is fully justified by its results.

Time and money are saved by this furnace, which savings are passed along to you. In addition, better quality brushes are made possible, with that degree of uniformity for which National Pyramid Brushes are famous.

An interesting moving picture film illustrating in detail the processes used in the manufacture of carbon brushes will gladly be shown on request to any organization of engineers or students.

NATIONAL CARBON COMPANY, INC.

Unit of Union Carbide UCC *and Carbon Corporation*

Carbon Sales Division — SILVER STRAND CABLE — Cleveland, Ohio

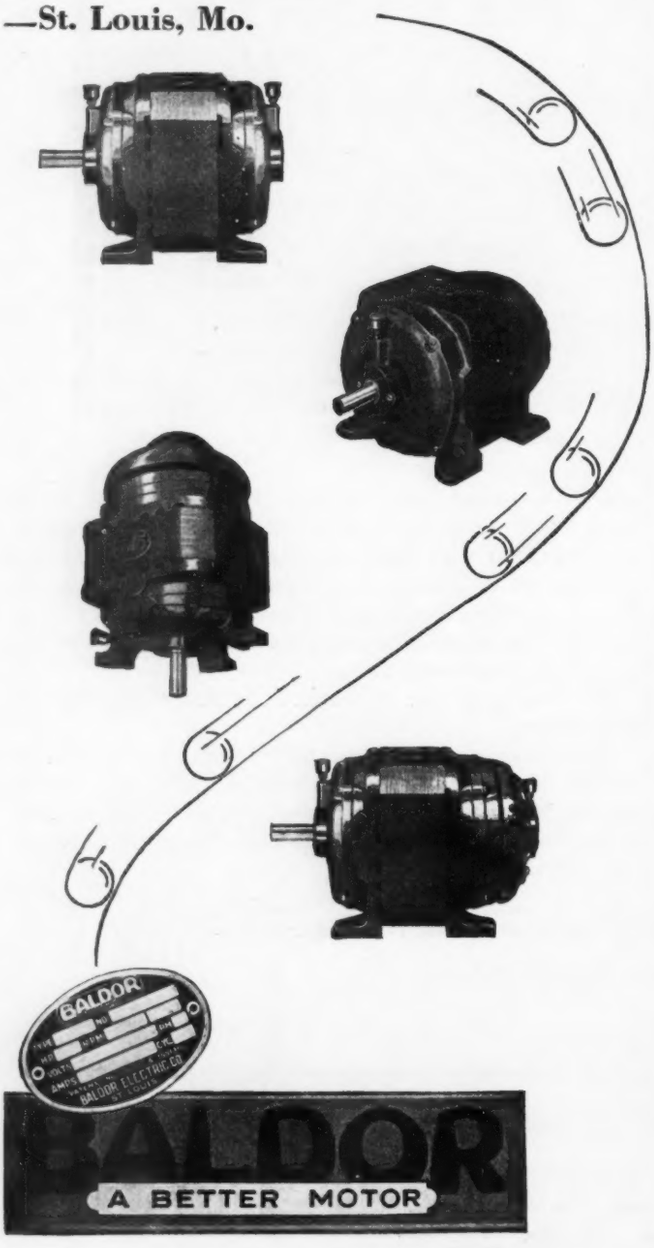
Branch Offices and Factories

New York Pittsburgh Chicago Birmingham San Francisco

Less Frequent Lubrication Required

because they are ball bearing equipped.

Ask for data and Bulletin that gives complete information. Baldor Electric Company—4354 Duncan Avenue —St. Louis, Mo.



Something To Try On Your *"Brush-eating"* Motors

For motors and generators that "eat up" brushes—try a set from U.S.G.

U.S.G. are the brushes that have the reputation for standing up longest under hardest usage.

They're tailor made—as to size and materials. Naturally they cost a little more—but they're worth it in superior performance, better commutation and longer life.

U.S.G. brushes sell themselves. One trial and they're "standard" from then on.

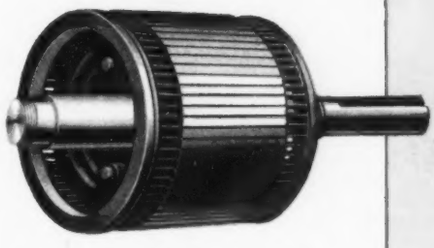
Let us make you a trial set.

The UNITED STATES GRAPHITE COMPANY

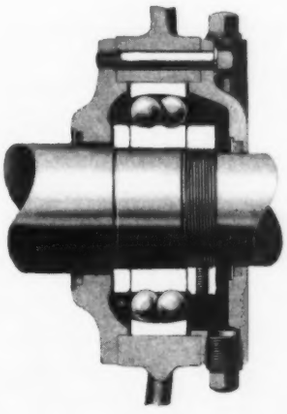
SAGINAW, MICHIGAN

Note the weight of frame, broad heavy feet and compact construction

You have a right to expect this of motors—



Short, thick shaft; rotor bars and end rings fused in to unit construction.



Once-a-year Lubrication

Sealed ball bearings require lubrication but once a year—further simplified by F-M Lubricant in measured tubes.

You have a right to look upon a motor as an investment. And as you judge a bond by its safety and yield, you have a right to judge a motor by its reputation for reliability and its yield in productive service. When you consider this sound method of evaluating electric motors price becomes a relative matter—the return in service per dollar invested becomes the determining factor of purchase.

Many leading plants have thus found that Fairbanks-Morse Ball Bearing Motors are "bargain" motors even though the initial price may be slightly higher than with sleeve bearing construction. They have found that these motors give a larger return in trouble-free service.

The greater value in F-M motors is not intangible. It is in the product itself and easily seen by the man who "knows motors." The responsibilities imposed by your service requirements are important enough that you inspect the actual motor. We are ready to arrange such an inspection in your plant at your convenience.

FAIRBANKS-MORSE MOTORS

Pioneer manufacturers of ball-bearing motors

FAIRBANKS-MORSE *Motors*

FAIRBANKS-MORSE *MOTORS*

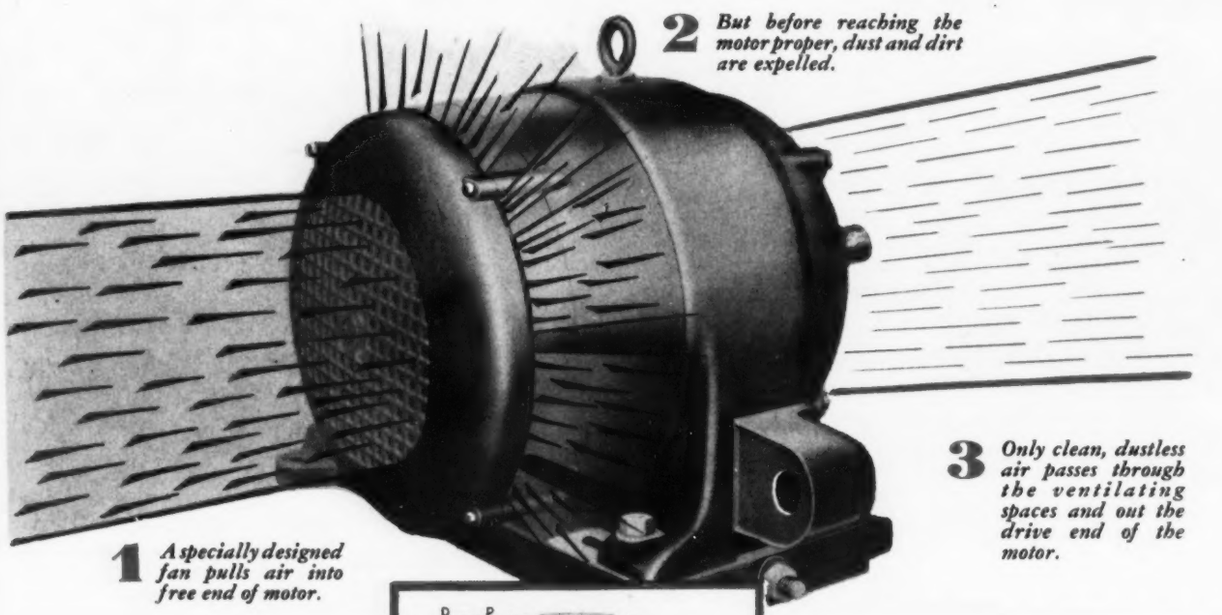
This motor *cleans its air before ventilating!*

An exclusive, patented feature of the Fairbanks-Morse Type HAC All-enclosed Motor! No breather and vent piping required—yet this motor supplies itself with pre-cleaned air.

A specially designed fan draws air into the free end of the motor—the fan is of such design that dust and dirt are immediately expelled and only clean air passes back through the motor ventilating spaces.

On the dustiest, dirtiest drive in your plant you can now have a fire safe, all-enclosed motor with no more installation cost than that of a standard, open type motor.

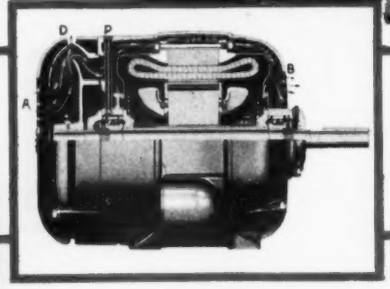
Be sure to write for full data on the Fairbanks-Morse Type HAC. Be prepared for your next installation requiring a dust-proof motor.



2 *But before reaching the motor proper, dust and dirt are expelled.*

1 *A specially designed fan pulls air into free end of motor.*

3 *Only clean, dustless air passes through the ventilating spaces and out the drive end of the motor.*



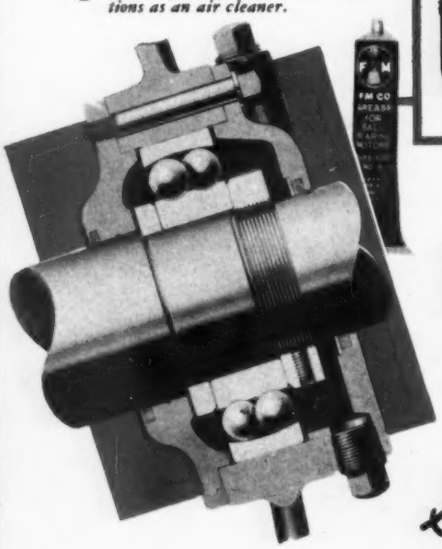
A *Air inlet at free end of motor.*

F *Specially designed fan which functions as an air cleaner.*

D *Vent for foreign particles thrown out centrifugally by fan.*

B *Clean air flows around winding shield and exhausts at opposite end of motor.*

P *Plunger device for greasing ball bearing without removing fan guard or bearing arms.*



EA40.23

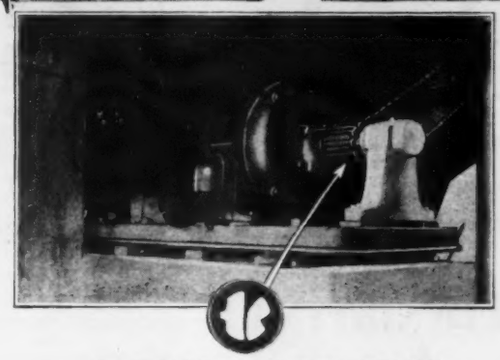
FAIRBANKS-MORSE & CO., *Chicago*

32 branches at your service throughout the United States

FAIRBANKS-MORSE MOTORS

Grease only once a year

MORSE CHAIN DRIVES Will Conserve Your Floor Space



100 H. P. MORSE SILENT CHAINS, *driving from motor to printing press equipped with Cutler Hammer Control, at the Houston Press, Houston, Texas.*

You can make every foot of your plant floor space productive when you are using Morse Silent Chain Drives for power transmission. They replace long belts, heavy gear trains, and expensive shafting. Their life is long and their upkeep very low. They protect your machines from injury due to sudden starts and stops, cut your overhead costs, and get the most out of your machines. Replacements are easy to make, and low in cost.

Power delivery to the point of use averages better than 98.6% over long periods of time.

For a more efficient plant and lowered costs all along the line, follow the lead of the leaders in American industry, and specify genuine Morse Silent Chains. A complete file of information on power transmission, of interest to every business man and every engineer will be sent you free of charge. Just write for it—there's no obligation.

MORSE CHAIN CO., ITHACA, NEW YORK

Branches in Principal Cities

MORSE SILENT CHAIN DRIVES

"WHY DID YOU CHOOSE SPEER BRUSHES—?"

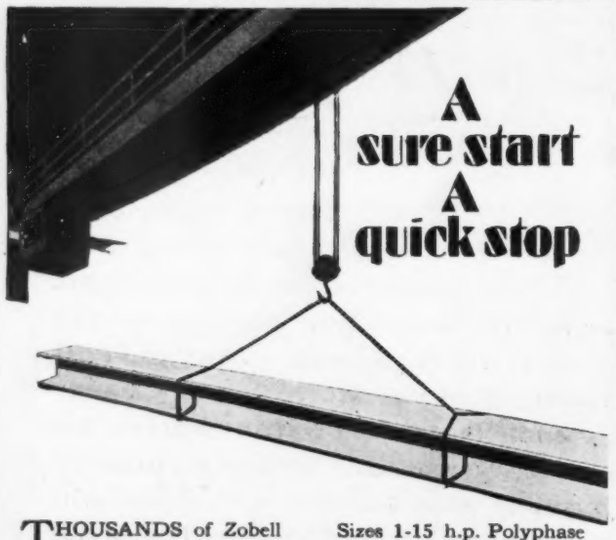
"BECAUSE of their record. On our 4,000 kw. rotaries we tested over a year for good commutation, uniform wear, quiet operation and good shunt connections. We standardize on Speer almost entirely!"

The question was ours. The answer was our customer's—a utility man whose name you'd know if we were free to publish it.

Speer Carbon Company, Saint Marys, Pennsylvania

Speer Carbon Brushes

⊕ 2794



THOUSANDS of Zobell Motors have been doing just this—for years—and it's no accident that the repair and spare parts ordered have been less than one per cent.

For Zobell Motors are not stock motors—they are custom built in quantities to meet your special requirements.

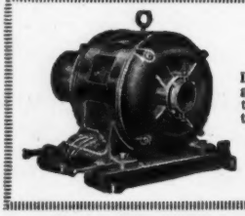
Zobell is the motor department for the manufacturers it serves. We would like an opportunity to figure on your most severe requirements first.

Sizes 1-15 h.p. Polyphase A.C. or D.C. Special shapes, shaft extensions and control systems.

ZOBELL ELECTRIC MOTOR CORPORATION
Garwood, New Jersey

ZOBELL HIGH TORQUE MOTORS
ZOBELL ELECTRIC MOTOR CORPORATION ⊕2929

DETROIT ELECTRIC FURNACES
will
Build Power Business
for
THE CENTRAL STATION
Let us help increase your revenue
Detroit Electric Furnace Co.
825 W. Elizabeth St., DETROIT



STAR
Ball Bearing Motors

Direct and Alternating Current up to 75 hp. Also generators and alternators in horizontal and vertical types, and motor generator sets. We build motors to meet your requirements. *Ask for more data.*

Star Electric Motor Co.
Miller St. and N. J. R. R. Ave.,
Newark, N. J.

BURKE ELECTRIC CO.
ERIE, PA.
MOTORS, ALTERNATORS, GENERATORS, MOTOR GENERATOR SETS, TRANSFORMERS, ARC WELDING EQUIPMENT
Sales Offices: Buffalo, Chicago, Cleveland, Detroit, Erie, New York, Philadelphia, Pittsburgh
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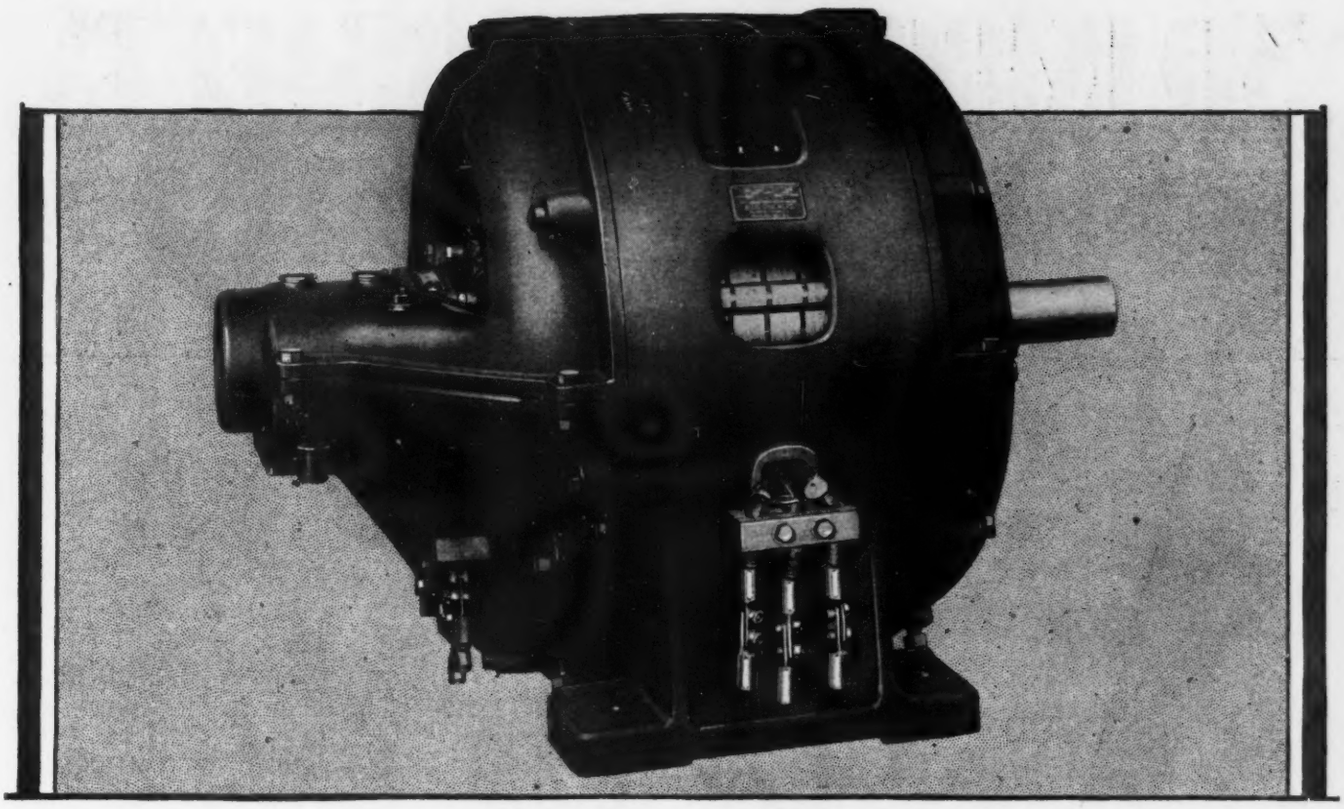
MARBLE-CARD MOTORS

D. C. and A. C., Ball Bearing Motors of the medium commercial sizes. D. C. machines up to 75 HP. with Commutating Poles. Get Bulletin No. 200.

A. C. Machines up to 75 HP. All standard speeds and voltages. Get Bulletin No. 300.

Special machines built to meet your needs. Full details cheerfully supplied. Write

Marble-Card Electric Company
Gladstone, Mich.



300 h. p., 800 r.p.m., Type ANY Wound Rotor Induction Motor

Sturdy Motors
— for Heavy Duty Service

Allis-Chalmers induction motors like all of the many products built by this Company are of sturdy construction enabling them to keep going regardless of the severity of the service. It is the extra quality and reserve strength that is built into these motors that keeps plants in production and lowers time needed for motor maintenance.

Rigid box type frames, large and dust proof bearings, and moisture resisting windings are a few of the characteristics of these motors. Another is the adjusting screws for centering the bearing brackets to insure a uniform air gap even after years of service.

Allis-Chalmers builds both squirrel cage and wound rotor motors for practically every type of service. Special types are built for unusual service conditions. These include vertical motors, drip-proof motors, steel mill motors, and various enclosed types. The heavier motors are built with pedestal bearings.

Allis-Chalmers electrical equipment includes machinery for the generation, transformation, conversion, and utilization of electric power.

ALLIS-CHALMERS MFG. CO.
MILWAUKEE, WISCONSIN

ALLIS-CHALMERS MOTORS

30 IMPORTANT SUBJECTS

SELECTION OF BEARING TYPE & SIZE
FELT GROOVES AND FELT RINGS
SHAFT SHOULDER DIAMETERS
GREASE-GROOVE SEALS
EXTERNAL SLINGERS
HOUSING BORE LIMITS
CARTRIDGE MOUNTINGS
ENGINEERING DATA
EQUIVALENT SIZES
LIMITING SPEEDS
LABYRINTH SEALS
SAFETY FACTORS
LEATHER SEALS
SPRING WASHERS
SHAFT LIMITS
END COVERS
CORK SEALS
LUBRICANTS
DIMENSIONS
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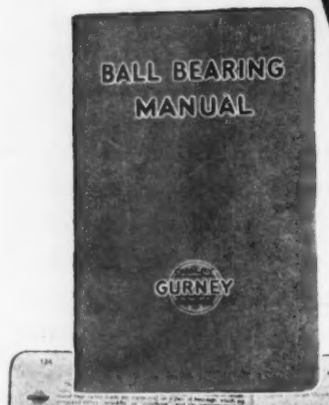
SEALS
OILS



This valuable 176 page Ball Bearing Manual is available without charge to Engineers, Designers and Draftsmen. Send for your copy today.

Gurney Ball Bearing Division
MARLIN-ROCKWELL CORPORATION
402 Chandler St. Jamestown, New York

GURNEY BALL BEARING MANUAL COVERS THEM ALL

If Uninterrupted Service and Long Life is Vital—Specify Falk! . . .

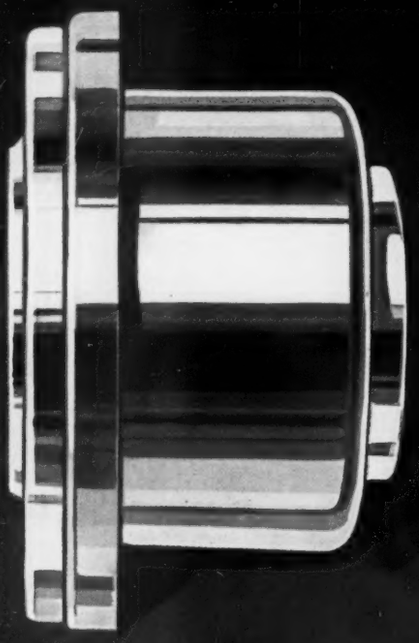
Among those industries where long and uninterrupted speed reducer service is of vital importance, there is a decided trend toward the Herringbone Gear Speed Reducer as it is built by Falk . . . For the gears in Falk Speed Reducers are cut from specially prepared steel blanks by a process exclusive with Falk . . . The Reducers are simple, compact, oil-tight, dirt-proof, noiseless, free from heat and vibration, permit a higher ratio of reduction per gear, transmit load and transform speed with less friction loss than any other type or kind . . . Read the features listed at right. Send for bulletins describing them in detail, or get in touch with any Falk representative . . .

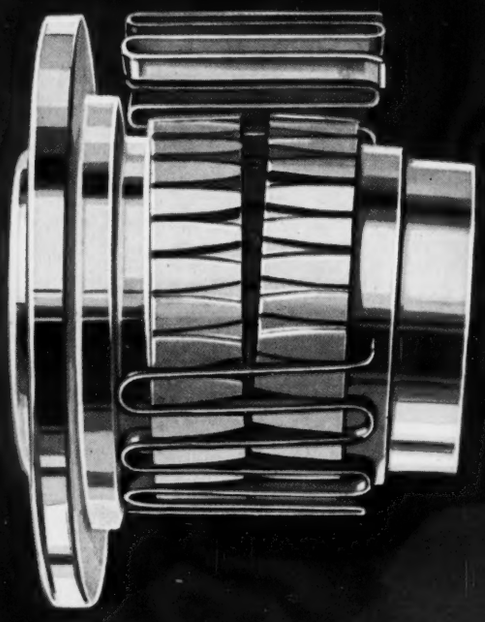
Here Are The Features!

Made in standard sizes and ratios and carried in stock for immediate shipment . . . Excessive capacity—unnecessary to buy oversize reducers . . . Symmetrical arrangement allows equal pressure on bearings and prevents uneven wear and misalignment. All wearing parts are interchangeable and renewable. The entire construction is simple and accessible . . . Patented splash system of lubrication . . . No male and female shafts, bushed gears or overhung studs—nothing but plain bearings and live shafts . . . Highest possible efficiency, maintained throughout life of reducer.

FALK

SPEED REDUCERS





Falk Flexible Couplings

Allow both lateral and torsional elasticity . . . Are easily connected and disconnected . . . Are all-steel . . . Provide widest distribution of pressure . . . Allow most correct lubrication . . . Float freely under load . . . Insure greatest resistance to overloads. Absorb shock and vibration . . . Accommodate parallel and angular misalignment . . . Can be lined up quickly without special tools . . . Cannot rust — springs are packed in grease . . . Have no unreliable elements, which lead to breakdowns . . . Operate equally well in both directions; either end can be the driver . . .

Other Falk Products — Gears, Speed Reducers, Oil Engines and Steel Castings.

Only the Falk Flexible Coupling Meets All These Requirements! . . .

To obtain the maximum benefit from a flexible coupling it must possess these advantages: It must be all-metal, amply lubricated; it must be both torsionally and laterally resilient; it must provide for both angular and parallel misalignment and it must absorb shocks...Only the Falk Flexible Coupling meets all of these requirements . . . Its design embodies a patented principal that makes for exceptional resiliency with ample strength, ease of installation, low upkeep cost, dependable operation . . . Send for Bulletin 180.

THE FALK CORPORATION—MILWAUKEE

NEW YORK	PITTSBURGH	DETROIT	SAN FRANCISCO	ST. LOUIS	ROCHESTER
ALBANY	AKRON	CHICAGO	PORTLAND	LOS ANGELES	CLEVELAND
WILKES-BARRE	BIRMINGHAM	DENVER	MINNEAPOLIS	HOUSTON	KALAMAZOO

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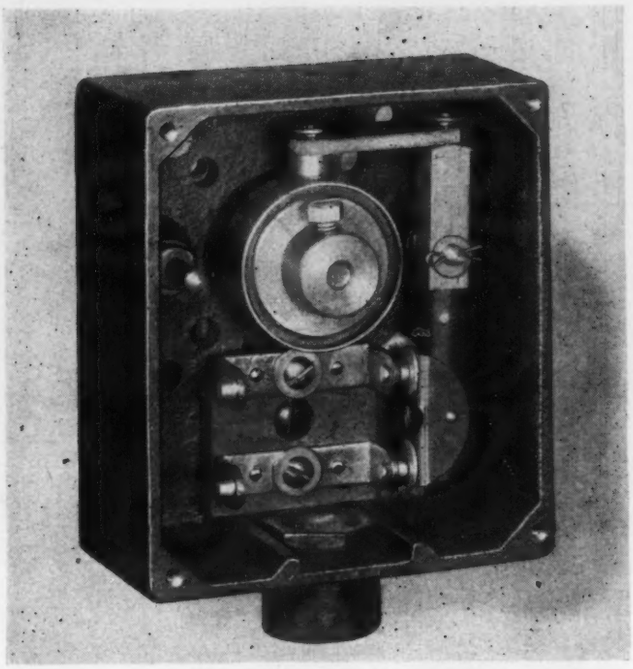
FALK

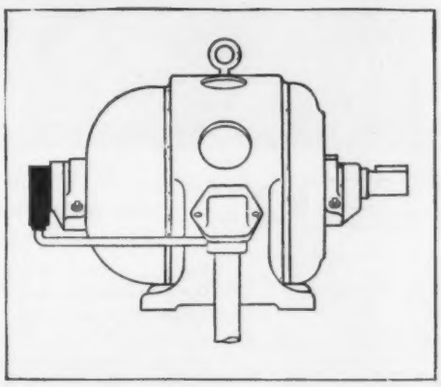
FLEXIBLE COUPLINGS

A *quick stop* *for* A. C. *motors*

Monitor does it with a new switch



A. C. Brake Switch mounted on motor end-bell with conduit to main connection box.



A SAFE, quick stop is important for many applications of a.c. motors.

The Monitor Controller Company has developed a new device...the A. C. Brake Switch. This switch is entirely mechanical in its operation. It is easy to install and so simple and substantial in construction as to guarantee reliable continuous service under the severest conditions. It is mounted on the free end of the motor which is to be controlled and its moving part attached to the end of the shaft.

Used with a Monitor Automatic Brake-stop Controller it maintains full braking torque until the motor comes to rest, thus giving a maximum rate of deceleration right up to the instant the motor stops.

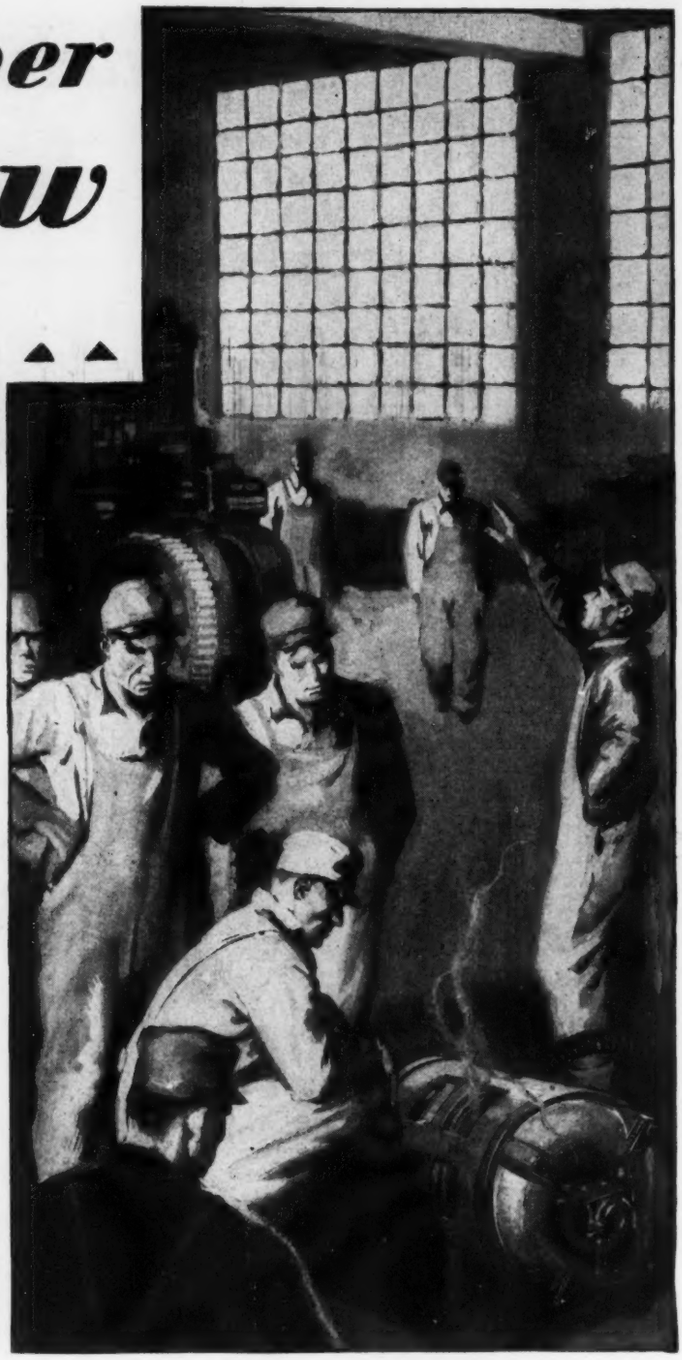
MONITOR CONTROLLER COMPANY
Gay, Lombard and Frederick Streets, Baltimore, Md.

IF YOU HAVE A CONTROL PROBLEM . . . CONSULT MONITOR

Monitor *does it automatically*

6536-4

. . . *remember* David *slew* Goliath . . .



GOLIATH was not prepared against a boy's weapons . . . a sling and a pebble. His disaster demoralized an army.

Your plant is undoubtedly protected against the failure of expensive equipment and large electric motors . . . but small machines and small motors fail, too. And accidents to them are all the more disastrous to morale because they *are* small, under-estimated in importance.

All motors deserve the best Motor Control to be had . . . *Modern* Motor Control which not only protects motors but protects them *accurately* so power is fully utilized . . . Motor Control which assures most convenient operation saving steps and time . . . Motor Control with reserve quality for long life.

The surest way to secure protection and the other advantages of Modern Motor Control throughout the plant is standardization upon a line of Motor Control known to be good in every capacity and type.

Cutler-Hammer Motor Control is used on every motor, every motor-driven machine in many leading plants . . . selected because of its progressive features of design . . . features which have set new standards of Motor Control performance. It is incorporated in many leading machines as standard equipment. And recommended by motor builders to assure the performance from their motors that you expect.

CUTLER-HAMMER, Inc.
Pioneer Manufacturers of Electric Control Apparatus
1285 St. Paul Avenue
MILWAUKEE, WISCONSIN

13

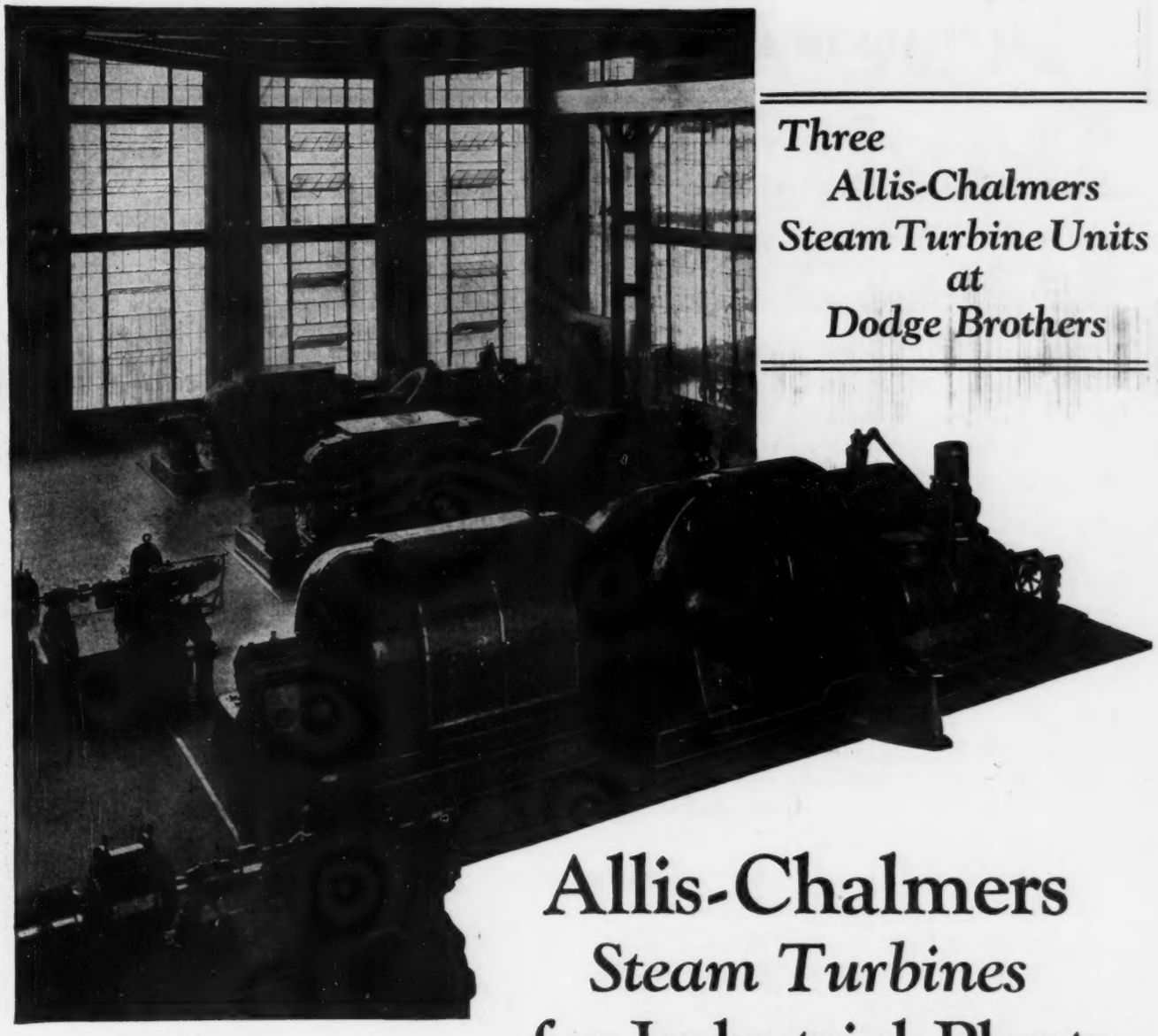
Thirteen Times the Manpower of Industry Hidden Away in Electric Motors

Electric motors in America's industries today provide working capacity equal to 250 million workmen. That is more than 13 times the actual number of men employed. How effectively this army of "unseen" workers is used to bring down costs is determined by the care with which Motor Control is selected.

CUTLER HAMMER

The Control Equipment Good Electric Motors Deserve

(8616)



Three Allis-Chalmers Steam Turbine Units at Dodge Brothers

Allis-Chalmers *Steam Turbines* —for Industrial Plants

Reliability is the primary requisite in power generating equipment in industry.

Allis-Chalmers Steam Turbine Units are KNOWN for reliability and efficiency.

The 10,000 K. W. Steam Turbine generator in the foreground is the fourth Allis-Chalmers unit installed in the Dodge Brothers power plant at Detroit.

A 750 K. W. unit (not shown) was installed in 1913—the two 4000 K. W. units in 1921 and the 10,000 K.W. in 1924. These repeat orders attest the satisfactory performance of A.C. Steam Turbines in actual operation.

ALLIS-CHALMERS MANUFACTURING CO.
MILWAUKEE, WIS., U.S.A.

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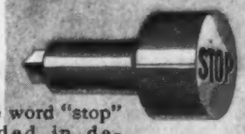
Control housing for temperature regulator.



Note word "stop" molded in depressed letters on this push button.

Molding used in connection with electrical control apparatus on ships.

Solving Manufacturing Problems With Belden Moldings

MANY manufacturers are obtaining the most surprisingly satisfactory results by replacing wood, metal, and cold molded parts with Belden Moldings of Bakelite, Durez, and kindred materials.

Belden Moldings are produced with a beautiful finish and an accuracy that requires the minimum finishing work. Screws, studs, holes, projections, and recessions can be molded in so accurately and smoothly that additional machining is unnecessary.

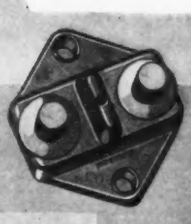
The uniformity in size and shape of Belden Moldings not only saves additional labor, but also makes for rapid assembly.

Perhaps Belden Moldings would prove more serviceable and more economical in the long run in some of your products. Send a sample or blue print of some parts that have been giving you trouble.

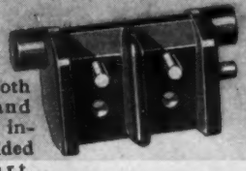
Let Belden Engineers tell you whether or not they can give you a molding which will better serve your purpose.

Belden Manufacturing Company

2312-B S. Western Ave. **Chicago, Illinois**



Large threads on one side with beveled inserts and eyelets on the other make this molding hard to produce.



Note that both vertical and horizontal inserts are molded in this part.

Insulator of special material which has mechanical strength approximately ten times that of bakelite having a wood flour filler.

BELDEN PRODUCTS

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Coil Windings
Beldenmold
(Molded Bakelite Products)
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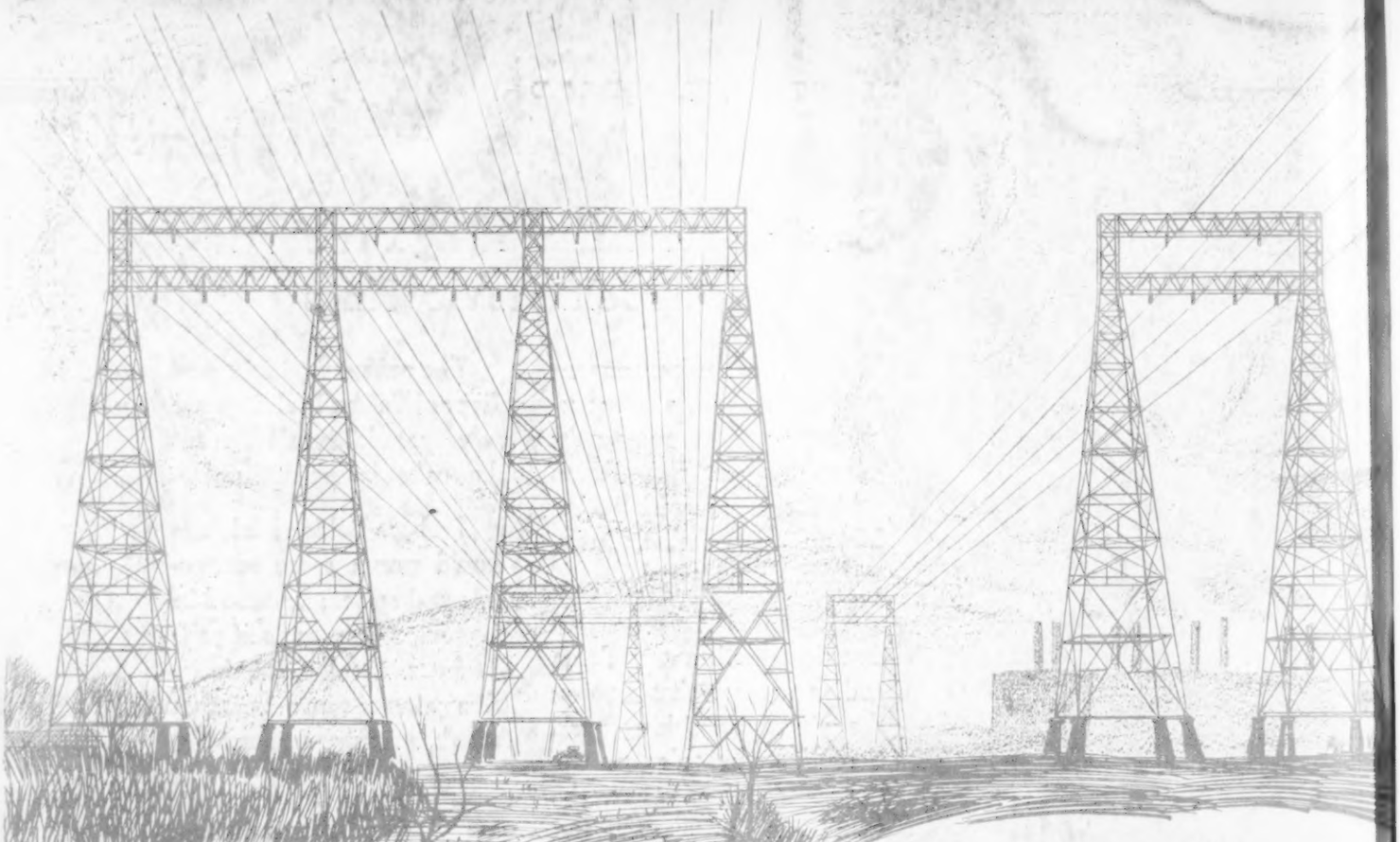
Radio Wires, Cords and Cables
Rubber Covered Wires
Armored Cables
Flexible Armature Wires
Motor Lead Wires
Braided and Stranded Copper Cables
Cotton Sleeving

Specify Belden



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